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December 15, 1990

Energy Research Abstracts

Abstracts 50256–52614

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

Scope

ERA is comprehensive in its subject scope, encompassing DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

Availability

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ERA is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription rate for 24 semimonthly issues is $184.00 for domestic subscribers and $230.00 for foreign subscribers. A single issue costs $27.00, domestic, or $33.75, foreign. Cumulative indexes are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The GPO Stock Number is 061-000-00749-1 for the Volume 14 indexes.

Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

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- United States

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2. **Report number** identification for report-type literature.
3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
11. **Number of pages** or page range.
12. **Language** of document if non-English.
13. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
14. **Publisher's name and location** for documents published by a corporate or commercial source.
15. **Sponsoring organization.**
16. **Contract or grant number.**
17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
19. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas. Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA)*, 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 Polarization of fast particle beams by collisional pumping. Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

How To Order from the Availability Sources

TO OBTAIN A REPORT

Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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INIS Clearinghouse
International Atomic Energy Agency
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Vienna, Austria

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5285 Port Royal Road
Springfield, VA 22161

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Books, conferences, and monographs The source for these publications is the publisher or the originating society, organization, or institution. DOE-supported conferences and individual papers reporting DOE-supported research may be available as reports from OSTI.

Foreign material The Linda Hall Library is an excellent source of foreign materials. For translations of foreign language material, contact the Library of Congress National Translation Center. For material difficult to locate, check with the British Library Document Supply Centre.

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816-363-4600

Library of Congress
National Translation Center
Washington, D.C. 20540
202-707-0100

British Library Document Supply Centre
Boston Spa, Weatherby
West Yorkshire
LS23 7BQ
United Kingdom

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
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Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438–
T1 15:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope*.

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17 WIND ENERGY

Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

Refer also to citation(s) 50274

0103 Preparation

Refer also to citation(s) 50325, 50326, 50758

50256 (CONF-9005183–, pp. 205-212) **Energetics of comminution.** Peterson, C.R. (Massachusetts Institute of Technology, Cambridge (USA)); McClintock, F.A. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media*. 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Continuing work in the processes of particle fracture within particle beds is presented. Experimental work on bed compression and fracture is qualitatively duplicated in computer simulations of two-dimensional beds of non-uniform spheres, including detailed behavior within the bed. The build-up and collapse of frictionally supported force structures within the bed are seen, and the distribution of energy in losses and storage is determined. Failure of multiply-loaded brittle spheres is dependent upon the maximum individual load only, but lateral loads can inhibit fracture of plastic spheres. A bed efficiency is defined and initial experimental investigations of efficiency as a function of compression parameters are presented. Means for transporting fine material from the active crushing zone are discussed and an initial experiment demonstrating very effective separation by size is presented. 10 refs., 8 figs.

50257 (DOE/PC/88853–T2) **Air-Sparged Hydrocyclone/ Advanced Froth Flotation fine coal cleaning: Final report.** Stoessner, R.D. (Pennsylvania Electric Co., Johnstown, PA (USA)); Shirey, G.A.; Zawadzki, E.A.; Welsh, C.F.; Miller, J.D.; Shell, W.P. Pennsylvania Electric Co., Johnstown, PA (USA); Management and Technical Systems, McMurray, PA (USA); Davy Dravo (USA); Utah Univ., Salt Lake City, UT (USA); Ebasco Services, Inc., New York, NY (USA). 27 May 1990. 344p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88853. Order Number DE90016410. Source: NTIS, PC A15/MF A01 - OSTI; GPO Dep.

In May 1988, the Pennsylvania Electric Company (Penelec) and New York State Electric and Gas Corporation (NYSEG) were awarded a contract from the Department of Energy's Pittsburgh Energy and Technology Center (DOE-PETC) to evaluate the performance of a two-inch Air-Sparged Hydrocyclone (ASH) for cleaning fine minus-100-mesh coal. A 24-month study was successfully completed, optimizing the performance of the ASH for cleaning raw classified, naturally-occurring minus-100-mesh Upper Freeport coal, and comparing its performance with Advanced Froth Flotation (AFF), a procedure utilizing conventional flotation equipment operated in an advanced manner (low impeller speeds, starvation float, multiple-stage cleaning, etc.) with highly selective reagents to optimize ash and pyritic sulfur rejection. The economics of cleaning fine coal by both processes at commercial scale, for retrofit and greenfield applications were found to be comparable within the accuracy of the study. Technical performance of the two processes were also found to be essentially identical. Thus, the ASH would be the best choice for a retrofit installation into an existing plant because of requiring less space. Both processes were successful in achieving excellent separations when cleaning the Upper Freeport coal. Both the ASH and AFF circuits were able to produce a clean-coal product of yield (65–80 percent weight recovery) and quality (5–6 percent ash) equivalent to that as theoretically determined by float-sink washability analyses. Combining either of the two fine coal flotation processes with a classifying cyclone circuit resulted in pyritic sulfur rejection values of about 85 percent. 47 refs., 109 figs., 75 tabs.

50258 (DOE/PC/88877–T4) **Coal surface control for advanced physical fine coal cleaning technologies: Annual report, September 19, 1988–December 31, 1989.** Morsi, B.I.; Chiang, S.H.; Sharkey, A.; Blachere, J.; Klinzing, G.; Streeter, R.; Gray, R.; Venkatadri, R.; Cheng, Y.S.; Chiarelli, P.; Perez, L.; Kim, S.; Ciocco, M.; Bi, H. Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering. [1990]. 551p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88877. Order Number DE90017874. Source: NTIS, PC A24/MF A01 - OSTI; GPO Dep.

The overall objective of the project is to develop techniques for coal surface control prior to the advanced physical fine coal cleaning process of selective agglomeration in order to achieve 90% pyrite sulfur rejection at a Btu recovery greater than 90% based on run-of-mine coal. The surface control is meant to encompass storage, grinding environments and media, surface modification during grinding and laboratory beneficiation testing. The eventual application of the techniques developed in this project will significantly contribute to the reduction of "acid rain". The project include the following tasks: project planning; method for analysis of samples which includes morphology, washability, petrography, wettability, zeta potential, surface functional groups, and particle size; development of standard beneficiation tests; and exploratory R&D and support. Coal samples to be used include three base coals, Upper Freeport – Indiana, PA, Pittsburgh #8 – Belmont, OH, and Illinois #6 – Randolph, IL, and three other coals which are Upper Freeport – Grant, WV, Kentucky #9 – Hopkins, KY, and Wyodak – Campbell, WY. 219 figs., 112 tabs.

50259 (DOE/PC/88878–T6) **Coal surface control for advanced fine coal flotation: Annual report, October 1, 1988–December 31, 1989.** Fuerstenau, D.W. (California Univ., Berkeley, CA (USA)); Sastry, K.V.S.; Hanson, J.S.; Narayanan, K.S.; Herrera-Urbina, R.; Diao, J.; Yin, Y.; Sotillo, F.; Harris, G.; Hu, Weibei; Zou, Y.; Chen, W.; Somasundaran, P.; Harris, C.C.; Vasudevan, T.; Xhong, K.;California Univ., Berkeley, CA (USA); Utah Univ., Salt Lake City, UT (USA); Columbia Univ., New York, NY (USA); Praxis Engineers, Inc., Milpitas, CA (USA). 28 Feb 1990. 325p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88878. Order Number DE90015370. Source: NTIS, PC A16/MF A01 - OSTI; GPO Dep.

The primary objective of this research project is to develop advanced flotation methods for coal cleaning in order to achieve 90% pyritic sulfur removal at 90% Btu recovery, using coal samples procured from six major US coal seams. Concomitantly, the ash content of these coals is to be reduced to 6% or less. Investigation of mechanisms for the control of coal and pyrite surfaces prior to fine coal flotation is an important aspect of the project objectives. The effect of the following additives on flotation response was investigated. These include methanol lethanol, butylbenzaldehyde, glyoxal and several monomers. A second major objective is to investigate factors involved in the progressive weathering and oxidation of coal that had been stored in three storage modes, namely, open, covered and in an "argon-inerted" atmosphere, over a period of twelve months. 33 refs., 134 figs., 98 tabs.

50260 (DOE/PC/88878–T8) **Coal surface control for advanced fine coal flotation: Quarterly report No. 7, April 1, 1990–June 30, 1990.** Fuerstenau, D.W. (California Univ., Berkeley, CA (USA)); Sastry, K.V.S.; Hanson, J.S.; Harris, G.; Sotillo, F.; Diao, J.; Somasundaran, P.; Harris, C.C.; Vasudevan, T.; Liu, D.; Li, C.; Hu, Weibai; Zou, Y.; Chen, W.; Choudhry, V.; Sehgal, R.; Ghosh, A. California Univ., Berkeley, CA (USA); Columbia Univ., New York, NY (USA); Utah Univ., Salt Lake City, UT (USA); Praxis Engineers, Inc., Milpitas, CA (USA). 15 Aug 1990. 53p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88878. Order Number DE91000914. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The primary objective of this research project is to develop advanced flotation methods for coal cleaning in order to achieve near

total pyritic-sulfur removal at 90% Btu recovery, using coal samples procured from six major US coal seams. Concomitantly, the ash content of these coals is to be reduced to 6% or less. Work this quarter concentrated on the following: washability studies, which included particle size distribution of the washability samples, and chemical analysis of washability test samples; characterization studies of induction time measurements, correlation between yield, combustible-material recovery (CMR), and heating-value recovery (HVR), and QA/QC for standard flotation tests and coal analyses; surface modification and control including testing of surface-modifying reagents, restoration of hydrophobicity to lab-oxidized coals, pH effects on coal flotation, and depression of pyritic sulfur in which pyrite depression with calcium cyanide and pyrite depression with xanthated reagents was investigated; flotation optimization and circuitry included staged reagent addition, cleaning and scavenging, and scavenging and middling recycling. Weathering studies are also discussed. 19 figs., 28 tabs.

50261 (DOE/PC/89909–T2) **In-plant testing of microbubble column flotation: First quarter technical progress report, September 26, 1989–December 31, 1989.** Yoon, R.H.; Luttrell, G.H.; Adel, G.T. Virginia Center for Coal and Minerals Processing, Blacksburg, VA (USA). [1989]. 83p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89909. Order Number DE91000011. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A project to evaluate the performance of the Virginia Tech Microbubble Column Flotation (MCF) process in an operating coal preparation plant was initiated during this past quarter. The project is concerned with the collection of process operating data using a 30-inch diameter column, and using this data to scale-up to a prototype, full-scale plant column. The work is being carried out at the Marrowbone Preparation Plant owned by the Shell Mining Corporation. Work has primarily concentrated on finalizing the project work plan (Task 2.1 – Project Planning), instrumenting the 30-inch diameter column (Task 2.2 – Advanced Instrumentation) and conducting a preliminary parametric study to evaluate the performance of the column (Task 2.3 – Detailed Testing). To date, the column has been consistently capable of producing a 9.5% ash product at a 61% combustible recovery from a -150 mesh classifying cyclone overflow containing 55–60% ash at 3–5% solids. Tests conducted over an extended period of time indicate that the column consistently maintains grade in spite of fluctuations in the feed characteristics. 12 figs.

50262 (NZERDC–163) **Peat dewatering: new opportunities and options.** Calonne, R.D. de; Bryant, R.W. New Zealand Energy Research and Development Committee, Auckland (New Zealand). Feb 1988. 16p. Source: Ministry of Commerce, Energy and Resources Division, PO Box 2337, Wellington, New Zealand.

A pre-feasibility study was conducted on a novel technology to dewater peat slurries from large scale wet mining operations. The study included bench scale testing of Ohinewai peat to establish the parameters for design and cost estimating of a plant. The results showed that peat slurries with 95% moisture content could be processed into peat cakes of fuel quality for 34 NZ dollars per tonne on a dry basis and interest rates up to 17% on capital investment. 11 refs., 21 figs.

0104 Processing

Refer also to citation(s) 50304, 50313, 50323, 50324, 50325, 50326, 50333, 50368, 50481, 50656, 50657, 50666, 50790, 51329

50263 (DOE/EA–0439) **The ENCOAL Mild Gasification Demonstration Project.** USDOE, Washington, DC (USA). Jul 1990. 27p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE91000832. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The DOE plans to enter into a Cooperative Agreement with ENCOAL Corporation, a wholly owned subsidiary of Shell Mining Company, for the cost-shared design, construction and operation of a mild gasification facility based on Liquids-from-Coal (LFC) technology. The facility is planned to be located at the Triton Coal Company's Buckskin Mine near Gillette, Wyoming. The mild gasification process to be demonstrated will produce two new, low-sulfur fuel forms (a solid and a liquid) from subbituminous coal. The new fuel forms would be suitable for combustion in commercial, industrial, and utility boilers. This environmental assessment has been prepared by the DOE to comply with the requirements of the NEPA. Pollutant emissions, land use, water, and waste management are briefly discussed. 3 figs., 5 tabs.

50264 (DOE/PC/79813–T5) **Advanced studies of biological indirect liquefaction of coal: Final report.** Arkansas Univ., Fayetteville, AR (USA). Dept. of Chemical Engineering. Jan 1990. 259p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC79813. Order Number DE90017260. Source: NTIS, PC A12/MF A01 - OSTI; GPO Dep.

During FY 87, a bacterial culture was isolated from animal waste that is capable of converting CO in synthesis gas to ethanol and acetate. The culture was tentatively identified as Clostridium. One objective of this project is to present the results of culture identification and characterization studies aimed at determining whether or not the culture is a new species. Another objective is to present the results of microbiological and engineering research aimed at eliminating acetate as a product from the biological conversion of CO in synthesis gas. It is desired to produce ethanol as the only product in as high a concentration as possible. Two approaches were taken in minimizing the amount of acetate in the product: controlling the hexose metabolism pathway through acetyl Co-A by regulating hydrogen availability, redox potential or culture morphology to remove acetate from the product stream; and manipulating the fermentation parameters to maximize ethanol production. Finally, the results of batch culture optimization studies aimed at determining the best operating condition for growth and ethanol production by C. ljungdahlii are reported. 78 refs., 136 figs., 10 tabs.

50265 (DOE/PC/79818–T2) **Bench-scale co-processing: Quarterly report No. 6, July 1, 1989–September 30, 1989.** Nafis, D.A.; Gatsis, J.G.; Lea, C.; Miller, M.A. UOP, Inc., Des Plaines, IL (USA). 7 Mar 1990. 38p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79818. Order Number DE91000916. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this current is to extend and optimize UOP's single-stage slurry-catalyzed co-processing scheme, which has developed under previous Contract AC22-84PC70002. Particular emphasis is given to defining and improving catalyst utilization and costs, evaluating alternative and disposable slurry-catalyst systems, and improving catalyst recycle and recovery techniques. The work during this quarter involved a series of bench-scale runs using a new Mo-based slurry catalyst. The results of bench-scale Runs 24 and 25 are discussed in the following report. 7 refs., 4 figs., 3 tabs.

50266 (DOE/PC/79818–T3) **Bench-scale co-processing: Quarterly report No. 7, October 1, 1989–December 31, 1989.** Nafis, D.A.; Gatsis, J.G.; Lea, C.; Miller, M.A. UOP, Inc., Des Plaines, IL (USA). 27 Mar 1990. 25p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79818. Order Number DE91000917. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this contract is to extend and optimize UOP's single-stage slurry-catalyzed co-processing scheme. Particular emphasis is given to defining and improving catalyst utilization and costs, evaluating alternative and disposable slurry-catalyst systems, and improving catalyst recycle and recovery techniques. The work during this quarter involved a series of temperature studies with different concentrations of Mo slurry catalyst. The results of bench-scale Runs 26 and 27 are discussed in the following report. 25 figs.

50267 (DOE/PC/79818–T4) **Bench-scale co-processing: Quarterly report No. 8, January 1, 1990–March 31, 1990.** Nafis, D.A.; Gatsis, J.G.; Lea, C.; Miller, M.A. UOP, Inc., Des Plaines, IL (USA). 9 Jul 1990. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79818. Order Number DE91000918. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this contract is to extend and optimize UOP's single-stage slurry-catalyzed co-processing scheme. Particular emphasis is given to defining and improving Mo catalyst utilization and cost, evaluating alternative and disposable slurry-catalyst systems, and improving catalyst recycle and recovery techniques. During the previous quarter, a catalyst concentration study was

completed. The study showed that the highest nondistillable conversions and liquid yields were achieved using liquid recycle at temperatures in the range of 450–460°C. At these high severity conditions, the liquid product yield and light ends yield were nearly independent of catalyst concentration. During the current quarter a follow-up study was conducted without catalyst. The objective of this study was to determine whether the improved high temperature operability was due to improved hydrodynamics resulting from the use of liquid recycle or whether catalyst, also plays a role, even at small concentrations. The results of bench-scale Run 28 are discussed in this report. 1 ref., 12 figs.

50268 (DOE/PC/79912–12) **Thiophene metabolism by E. coli: Technical progress report, June 16, 1990–September 15, 1990.** Clark, D.P. Southern Illinois Univ., Carbondale, IL (USA). Dept. of Microbiology. [1990]. 16p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79912. Order Number DE91000851. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this project is to investigate the mechanism of degradation of sulfur containing heterocyclic molecules such as those found in coal, by mutants of Escherichia coli K-12. We previously isolated multiple mutants of E. coli which were selected for improved oxidation of furan and thiophene derivatives. We have focused on the thdA mutation in our subsequent research as it appears to be of central importance in thiophene oxidation. We hope that analysis of the thd genes of E. coli will lead to improvement of our thiophene metabolizing bacterial strains. 1 tab.

50269 (DOE/PC/79933–T9) **Effectiveness factors for hydroprocessing of coal and coal liquids: Progress report No. 11, March 16, 1990–June 15, 1990.** Massoth, F.E.; Seader, J.D. Utah Univ., Salt Lake City, UT (USA). 28 Jun 1990. 26p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79933. Order Number DE90017880. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The aim of this project is to develop a methodology to predict, from a knowledge of feed and catalyst properties, effectiveness factors for catalytic hydroprocessing of coal and coal liquids. The research entails a study of hydrodenitrogenation of model compounds and coal-derived liquids using three NiMo/alumina catalysts of different pore size to develop, for restrictive diffusion. During this quarter equilibrium adsorption studies of single and binary solutes in cyclohexane solvent on three NiMo catalysts were completed. Three single solutes, 9-phenylanthracene, 9-phenylcarbazole, and 9-phenylacridine; and two binary-solute mixtures (9-PhAn/9-PhC and 9-PhC/9-PhAn) were used for the studies. Mathematical models for sorptive diffusion on single- and binary-solute systems were developed. The previously hydrotreated coal-derived-liquid was subjected to a secondary hydrotreatment to achieve a satisfactory product quality. The oil was thoroughly analyzed. Hydrogenation of two nickel-porphines were carried out in this oil and the kinetics was studied with two catalysts under the process conditions. Reaction rates and restrictive diffusion effects were compared to those obtained in the pure solvents from the previous studies. 6 refs., 6 figs., 4 tabs.

50270 (DOE/PC/88810–6) **Development of analytical procedures for coprocessing: Quarterly technical progress report, January 1–March 31, 1990.** Vogh, J.W.; Anderson, R.P. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). May 1990. 37p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88810. Order Number DE91000852. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Maya crude residue and Illinois No. 6 coal have been processed together over a range of reactant ratios to produce material for study of the product composition and of the coprocessing chemistry. The reaction conditions have been described in previous reports. Acid fractions have been derivatized to produce ^{13}C tagged products suitable for NMR analysis. The acids have been identified as phenols and other oxygen acids, nitrogen acids including carbazoles, and benzylic and sulfur acids. All of the acid fractions appear to be essentially monofunctional. Base fractions were analyzed by nonaqueous titration and were shown to consist of azaarenes and arylamines. Two of the distillates boiling below 175°C were analyzed by PIANO capillary gas chromatography. Maya crude petroleum fractions similar to those obtained from coprocessing products have been analyzed for carbon isotope ratios. These fractions were prepared directly from the Maya crude without application of hydrogenation or other processing chemistry. Trends indicating isotopic fractionation coprocessing to that reported earlier for coprocessing products were observed. 14 figs., 13 tabs.

50271 (DOE/PC/88920–T7) **Electrochemistry of *Thiobacillus ferrooxidans* reactions with pyrite: Quarterly technical progress report, January 1990–May 1990.** Pesic, B.; Oliver, D.J. Idaho Univ., Moscow, ID (USA). Coll. of Mines and Earth Resources. 1990. 8p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88920. Order Number DE91000919. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this project is to provide the fundamental information on the mechanisms of bacterial leaching of pyrite. The knowledge of how bacterial leaching of pyrite functions is essential for design and development of a technology for coal cleaning with bacteria. The features of major electrochemical techniques will be examined to find out if any of them can provide a diagnostic information on the mechanisms of related reactions. This quarter the activity of T. ferrooxidans with duration of fermentation was examined. It was found that there were three distinct stages of fermentation. 1 fig.

50272 (DOE/PC/88935–T6) **Inhibition of retrogressive reactions in coal/petroleum co-processing: Quarterly technical progress report, March 1, 1990–May 31, 1990.** Schobert, H.; Tomic, J.; Moyer, D.; McConnie, J. Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences. Jun 1990. 42p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88935. Order Number DE90017884. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall objective of this project is to develop a fundamental understanding of the reaction occurring at the onset of coke formation during the co-processing of coals with petroleum residua. The specific objectives include examination of chemical components, or groups of components, in coals and petroleum feedstocks to quantify and rank the effects of these components in retarding or enhancement of coke formation. Work involves bench scale reactions in microautoclaves, supplemented by studies of the carbonaceous residues by such techniques as diffuse reflectance Fourier transform infrared spectroscopy and ^{13}C nuclear magnetic resonance spectrometry. Work this quarter involved the solvation and dispersion relationship involving the reactions of coals with five model compounds: eicosane, 1-phenyldodecane, 1,4-diisopropylbenzene, durene, and pyrene. Previous results indicated the need to investigate reactions at 400°C since the data obtained at 350°C and 450°C seem to represent the extreme ends in terms of reaction severity. Thermal stability of the coal, model compounds, and a resid have been tested at these temperatures, also. Baseline ^{13}C NMR data of the coals was obtained again, to improve the quality of the spectra. Collection of DRIFT spectra of the insoluble residue has been continued. C and H composition of the insoluble residue was determined. 4 refs.

50273 (DOE/PC/88942–T4) **Novel supports for coal liquefaction catalysts: Quarterly report No. 7, March 1, 1990–May 31, 1990.** Haynes, H.W. Jr. Wyoming Univ., Laramie, WY (USA). Dept. of Chemical Engineering. 26 Jun 1990. 19p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88942. Order Number DE90017876. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Objectives of this research are first to construct a Catalytic Coal Liquefaction Microreactor (CCLM) and then to use this unit to screen catalysts prepared from novel and/or modified supports for coal liquefaction applications. Modified supports will include aluminas treated with alkali and alkaline earth metals and halogens. Novel supports will include carbons, single component oxides and composite oxides. Efforts will be made to correlate coking tendency with catalyst acidity measurements. Pore structures of all catalyst samples, both fresh and spent, will be monitored routinely. Efforts during the last quarter were devoted primarily to shakedown runs of the CCLM and to subsequent modifications of the unit. Two runs were attempted. These initial runs have been hydrotreating runs on

a raw creosote oil. The catalyst is our benchmark AMOCAT 1A catalyst, a $CoMo/Al_2O_3$ catalyst in the form of 1/16 inch extrudates. 9 refs., 3 figs., 7 tabs.

50274 (DOE/PC/89659–T1) **Final environmental information volume for the coke oven gas cleaning project at the Bethlehem Steel Corporation Sparrows Point Plant.** Environmental Resources Management, Inc., West Chester, PA (USA). 24 Apr 1990. 166p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-90PC89659. Order Number DE91000014. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Bethelehem Steel Corporation (BSC) is planning to conduct a demonstration project involving an integrated system that can be retrofitted into coke oven gas handling systems to address a variety of environmental and operational factors in a more cost-effective manner. Successful application of this technology to existing US coke plants could: (1) reduce emissions of sulfur dioxide, cyanide, and volatile organic compounds (including benzene) (2) reduce the cost and handling of processing feed chemicals, (3) disposal costs of nuisance by-products and (4) increase reliability and reduce operation/maintenance requirements for coke oven gas desulfurization systems. The proposed system will remove sulfur from the coke oven gas in the form of hydrogen sulfide using the ammonia indigenous to the gas as the primary reactive chemical. Ammonia and hydrogen cyanide are also removed in this process. The hydrogen sulfide removed from the coke oven gas in routed to a modified Claus plant for conversion to a saleable sulfur by-product. Ammonia and hydrogen cyanide will be catalytically converted to hydrogen, nitrogen, carbon dioxide, and carbon monoxide. The tail gas from the sulfur recovery unit is recycled to the coke oven gas stream, upstream of the new gas cleaning system. The proposed demonstration project will be installed at the existing coke oven facilities at BSC's Sparrows Point Plant. This volume describes the proposed actions and the resulting environmental impacts. 21 refs., 19 figs., 9 tabs.

50275 (DOE/PC/90013–T13) **Optimum catalytic process for alcohol fuels from syngas: Thirteenth quarterly technical progress report, January–March 1990.** Union Carbide Chemicals and Plastics Co., Inc., South Charleston, WV (USA). Solvents and Coatings Materials Div. 28 Apr 1990. 50p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90013. Order Number DE91000985. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objectives of this contract are to discover and evaluate the catalytic properties of novel homogeneous, heterogeneous, or combination catalytic systems for the production of alcohol fuel extenders from syngas, to evaluate analytically and on the bench scale novel reactor concepts for use in converting syngas to liquid fuel products, and to develop on the bench scale the best combination of chemistry, reactor, and total process configuration to achieve the minimum product cost for conversion of syngas to liquid fuel products. Methanol production and heterogeneous catalysis utilizing transition elements supported on metal oxides with spinel structure are discussed. 12 figs., 16 tabs.

50276 (DOE/PC/90523–T5) **Phase behavior of coal fluids: Data for correlation development: [Quarterly progress report], April 15–July 15, 1990.** Robinson, R.L. Jr.; Gasem, K.A.M.; Darwish, N.A. Oklahoma State Univ., Stillwater, OK (USA). School of Chemical Engineering. [1990]. 29p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90523. Order Number DE91000633. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effective design and operation of processes for conversion of coal to fluid fuels requires accurate knowledge of the phase behavior of the fluid mixtures encountered in the conversion process. The overall objective of the author's work is to develop accurate predictive methods for representation of vapor-liquid equilibria in systems encountered in coal conversion processes. Objectives include: Measurements of binary vapor-liquid phase behavior data for selected solute gases (e.g. CO_2 and C_2H_6) in a series of heavy hydrocarbon solvents to permit evaluation of interaction parameters in models for phase behavior. Measurements on ternary systems in which high-melting-point solvents are dissolved in more volatile aromatics to provide mixed solvents. Evaluation of existing equations-of-state and other models for representation of phase behavior in systems of the type studied experimentally; development of new correlation frameworks as needed. Generalization of the interaction parameters for the solutes studied to a wide spectrum of heavy solvents; presentations of final results in formats useful in the design/optimization of coal liquefaction processes. This quarter, binary solubility data were measured for methane in four aromatic hydrocarbons at temperatures from 323 to 433 K (122 to 320°F) and pressures up to 11.3 MPa (1640 psia). The hydrocarbons studied are: benzene, naphthalene, phenanthrene and pyrene. 23 refs., 9 figs., 10 tabs.

50277 (DOE/PC/90523–T6) **Phase behavior of coal fluids: Data for correlation development: [Quarterly progress report], October 15, 1989–January 15, 1990.** Robinson, R.J. Jr.; Gasem, K.A.M.; Shaver, R.D. Oklahoma State Univ., Stillwater, OK (USA). School of Chemical Engineering. [1990]. 41p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90523. Order Number DE91000632. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effective design and operation of processes for conversion of coal to fluid fuels requires accurate knowledge of the phase behavior of the fluid mixtures encountered in the conversion process. The overall objective of the author's work is to develop accurate predictive methods for representation of vapor-liquid equilibria in systems encountered in coal conversion processes. The objectives of the present project include: (1) measurements of binary vapor-liquid phase behavior data for selected solute gases (e.g. CO_2 and C_2H_6) in a series of heavy hydrocarbon solvents to permit evaluation of interaction parameters in models for phase behavior, (2) measurements on ternary systems in which high-melting-point solvents are dissolved in more volatile aromatics to provide mixed solvents, (3) evaluation of existing equations-of-state and other models for representation of phase behavior in systems of the type studied experimentally; development of new correlation frameworks as needed, and (4) generalization of the interaction parameters for the solutes studied to a wide spectrum of heavy solvents; presentations of final results in formats useful in the design/optimization of coal liquefaction processes. This quarter, our framework for correlating saturation properties using a "scaled-variable-reduced-coordinate" approach was further developed to provide for generalized vapor pressure predictions. 59 refs., 6 figs., 8 tabs.

50278 (DOE/PC/91257–T5) **Molten-Caustic-Leaching (Gravimelt) system integration project: Topical report for test circuit procurement, fabrication, installation, shakedown, and test plan formulation.** TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div. Mar 1990. 222p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC91257. Order Number DE91000003. Source: NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The objectives of the tasks covered in this document are to design, construct, and shakedown a 20 pounds of coal per hour integrated MCL test circuit to demonstrate the feasibility of the technology for producing a demineralized and desulfurized coal that meets New Source Performance Standards (NSPS). These objectives were met with the construction and shakedown of the integrated test circuit. Although mild kiln conditions (340°C and 2 hours residence time) and a low caustic to coal ratio (1 to 1) were used, the combination of continuous operation and rigorous exclusion of air from the system allowed the production of MCL coal, from high sulfur, high ash coal, which has virtually no carbonate and volatiles loss, which does not form excessively wet cakes in during washing, and which has low alkali retention by the product MCL coal. Equipment performance was generally consistent with design requirements.

50279 (EPRI-ER–6572, pp. 2.1-2.17) **Reactors for scaling-up coal bioprocessing.** Andrews, G. (Idaho National Engineering Laboratory, Idaho Falls (USA)). Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Although considerable research has been done on the biochemistry and microbiology of coal bioprocessing, relatively little attention has been paid to the type of reactor in which these processes could be carried out on a commercial scale. This is unfortunate for two reasons. First, no bioreactors currently exist for large-volume low value solid products like coal. Second, the cost of building the reactor will be a major factor in the overall process economics, so any realistic judgment of the economic feasibility of these processes must await the selection, optimization and first-stage scale-up of the reactor. The reactor must provide, at minimum cost, an environment in which the highest possible number of cells can work at their maximum specific rates. This implies a high concentration of finely ground coal and rapid transfer of nutrients (including O_2) and products to and from the coal surface. Unfortunately these are mutually exclusive without a large investment in energy for mixing. Some cell recycle will be essential to keep the microbial concentration high without the cost of buying nutrients to grow new microorganisms. Possible bioreactor types, including slurry reactors heap reactors and fluidized beds are discussed along with new problems arising from the possible use of genetically engineered organisms.

50280 (EPRI-ER–6572, pp. 2.19-2.37) **Sulfur metabolism and the coal desulfurization potential of Sulfolobus brierleyi and Thiobacilli.** Khalid, A.M. (Univ. of Kentucky, Lexington (USA)); Bhattacharyya, D.; Aleem, M.I.H. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Metabolism of inorganic sulfur compounds as well as the removal of inorganic and the organic sulfur components of low sulfur (3.4%) and high sulfur (5.0%) coals was investigated using axenic cultures of Sulfolobus brierleyi, Thiobacillus thiooxidans and Thiobaciiius ferrooxidans. All of the organisms removed over 90% of the pyritic sulfur but organic sulfur was not removed. Acclimitization of S. brierleyi to high sulfur coal resulted in 35-40% removal of organic sulfur. Thus a multi-organism approach for cleaning up coal seems feasible. Since sulfur oxidizing mechanisms in S. brierleyi are obscure, its inorganic sulfur metabolism was studied. Intact cells catalyzed oxidation of S^{2-}, S^0, $S_2O^{2-}{}_3$, $S_4O^{2-}{}_6$, and $SO^{2-}{}_3$ yielded complete stoichiometries of O_2 used and $SO^{2-}{}_4$ formed. Pyritic sulfur of coal was also oxidized at a rapid rate at pH 2.0 and 60°C. The cellular components or the biocatalysts involved in this process were the flavoproteins and cytochromes of b, c and a types in Thiobacillus ferrooxidans and Thiobacillus thiooxidans while cytochrome c was absent in Sulfolobus brierleyi.

50281 (EPRI-ER–6572, pp. 2.107-2.117) **Studies on dibenzothiophene degrading bacteria.** Key, D. (Idaho National Engineering Laboratory, Idaho Falls (USA)); Willey, M.S.; Kase, R.S.; Ward, T.E. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The authors are studying the interaction of several bacterial isolates with dibenzothiophene (DBT), a sulfur-containing model compound similar to some of the sulfur-containing components of fossil fuels. The goal is to use these bacteria for microbiological coal desulfurization. Approximately 20 strains that metabolize DBT have been identified using an assay based on the oxidation/reduction indicator dye triphenyltetrazolium chloride (TTC). These isolates possess different types of interactions with DBT, based on the variety of physiological responses observed. The extent to which these isolates degrade DBT under specific conditions has been quantitated, using chloroform extraction of entire cultures followed by gas chromatographic analysis, and ranges from zero to about 60%. Some of the strains have been tentatively identified as Pseudomonas species. Studies of the metabolites produced from DBT by these isolates are in progress.

50282 (EPRI-ER–6572, pp. 2.71-2.85) **Enzymatic desulfurization reactions in hydrated organic media.** Marquis, J.K. (Boston Univ. School of Medicine, MA (USA)); Kitchell, J.P. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Efforts to develop clean coal technology are focused on the advantages of enzymatic desulfurization techniques. The authors have specifically investigated the potential of using partially-purified extracellular microbial enzymes and commercially available enzymes to remove sulfur from model organic compounds. The work includes the development of hydrous solvent systems, comprised of specific ratios of buffer: organic solvent, that permit enzymatic reactions of horseradish peroxidase and laccase with hydrophobic substrates such as the model organic sulfur compounds dibenzothiophene and ethylphenylsulfide. In order to further understand the interactions of enzymes and these model compounds, they have conducted an extensive series of kinetic studies with three enzymes (laccase, horseradish peroxidase, and sulfatase) and evaluated the inhibition of these enzymes by the model coal compounds and their sulfur oxidation products. The inhibitions observed, interpreted as a potential measure of binding within the domain of the active site, have implications for the planning or efficacious coal processing.

50283 (EPRI-ER–6572, pp. 3.1-3.28) **Biosolubilization of coal: Process, product, and applications.** Bean, R.M. (Pacific Northwest Laboratories, Richland, WA (USA)); Fredrickson, J.K.; Campbell, J.A.; Stewart, D.L.; Franz, J.A.; Thomas, B.L.; McCulloch, M.; Linehan, J.C.; Wilson, B.W. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Biosolubilization is a process for converting some coals to a water-soluble material. The phenomenon has been under intense investigation in a number of research laboratories for the past few years. During that time, conditions necessary for accomplishing the conversion have been described, the physical and chemical nature of the product has been characterized, but the mechanisms and the microbially produced reagents responsible for the process are still poorly understood. This paper reviews current knowledge of biosolubilization and biosolubilized coals, summarizes recent laboratory data about the nature of the biosolubilizing species, and discusses recent work to apply biosolubilization to the development of improved materials and processes.

50284 (EPRI-ER–6572, pp. 3.29-3.41) **The influence of microbial metabolites on low-rank coals solubility in alkaline solutions.** Quigley, D.R. (Idaho National Engineering Laboratory, Idaho Falls (USA)); Dugan, P.R. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Acid extraction of coal at ambient temperatures and pressures under nonoxidizing conditions can remove small amounts of mineral matter. Acid extracts contained primarily iron and calcium. The removal of this mineral matter enhances the solubilities of low rank coals tested from 145 to 675% in dilute alkaline solutions. This treatment also enhances the abilities of microorganisms to solubilize coals. These data suggest that multivalent cations bind with coals in such as way as to render them more insoluble in alkaline solutions and more resistant to microbial solubilization. Preliminary work indicates that those microorganisms which are more efficient coal solubilizers use extracellular substances that are active on the metal components of coal to enhance solubilities.

50285 (EPRI-ER–6572, pp. 3.99-3.127) **Biological conversions of low-rank coals.** Barik, S. (ARCTECH, Inc., Alexandria,

VA (USA)); Wyza, R.; Isbister, J.D. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582--: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

A review of ARCTECH's studies investigating bioconversion of low-rank coals is presented. Initial studies focused on mechanisms by which aerobic microorganisms solubilized coals to yield a mixture of water soluble products. Results indicated that biosolubilization of coals is most likely mediated by a combination of biological and non-biological factors. Model compound studies showed that a variety of bonds thought to be present in coal could be cleaved by the biological agent(s). Anaerobic microbial consortia isolated from a number of environmental niches have demonstrated direct conversion of several coals to methane. Texas lignite was converted by a termite-derived culture to methane with greater than 60% coal carbon conversion. Inhibition of biological methane production from coal by 2-bromoethanesulfonic acid or monensin was found to be culture and coal dependent. Data indicate that microbe/coal specificity could require specific microbial consortia for conversion of a selected coal.

50286 (EPRI-GS-6970) **Proceedings: 1990 first international symposium on the biological processing of coal.** Electric Power Research Inst., Palo Alto, CA (USA). ©Sep 1990. 501p. Sponsored by U.S. DOE Fossil Energy; Electric Power Research Institute. (CONF-900531--: 1. 1990 international symposium on the biological processing of coal, Orlando, FL (USA), 1-3 May 1990). Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The DOE/EPRI First International Symposium on Biological Processing of Coal was held on May 1–3, 1990, in Orlando, Florida. The symposium was held to help foster and increased awareness among the research community and utility industry of this developing area, to act as a forum for constructive review of existing projects and to fuel new ideas in the bioprocessing area. Topics that were discussed included coal science and advanced analytical techniques, microbial beneficiation of coal, biosolubilization of coal and product utilization, and bioremediation of coal-derived substances. Individual projects are processed separately for the data bases.

50287 (EUR–12349-FR) **Study of the transitory stages of the coking process.** Vidal, R. Centre de Recherches Metallurgiques, Liege (Belgium). 1990. 125p. (In French). Source: Commission of the European Communities, Luxembourg.

Tests were carried out on a battery of 26 underjet-type ovens at the Cockerill Sambre coke plant in Marchienne. In addition to conventional control systems, the battery is provided with a computerized system which allows for the systematic measurement of the temperature of the oven walls, the surface of the coke cake during pushing, the coke in the coke car before quenching and the temperature of the distillation gases in several ascension pipes. The effects of reduction in the heat supply in a single flue and then in twin flues were investigated, followed by characterisation of the effects of the momentary interruption of the heating of twin flues and then of an entire heating wall. Also quantified were the effects of an increase followed by a reduction in the heat supply in a single heating wall or in the two heating walls surrounding oven no. 5. Finally, the effects of a change in the type of heating gas were studied and the behaviour of an empty oven during degraphitisation monitored. A transfer function was established linking the temperature of the waste gases in the top part of the flues to the heat supply. This function is characterised by a time delay of generally < 10 mins. and a time constant of usually < 7 hrs. A correlation was also found to exist between the temperature of the waste gases in the top part of the heating flues and the temperature of the oven walls or the surface temperature of the coke cake. Other correlations were also found between operating parameters. 65 figs., 3 tabs.

50288 (EUR–12350-IT) **Influence of charge density on coking in a wide chamber oven.** Coletta, A. Centro Sviluppo Materiali SpA, Rome (Italy). 1990. 82p. (In Italian). Source: Commission of the European Communities, Luxembourg.

The use of wider coke ovens can lead to a reduction in pollutant emissions and operating costs of coke batteries, and an increase in productivity (kg/man hour), compared with narrower designs. Hourly production (kg/m^2/h) is lower, however, but this can be counter-acted by modifying the charge density. This report describes research into the influence of charge density on the coking process in wide ovens (550 mm) and means of modifying charge density. The research was conducted on pilot plant scale using CSM's experimental coking facility. The programme included coking tests an various blends in a 450 mm wide oven and tests with the same blends and with individual coals using a 550 mm oven. Two different charge densities were studied, which were obtained by adding substances to the coke blend that may/may not participate in the coking process. Tests were thus run with charges partially pelletized, compacted and with the addition of fuel oil, together with surfactants. Blends conditioned with 30% pellets or 3.3% fuel oil were found to have charge densities about 5.5% higher than normal; the drop in productivity due to the more than proportional increase in distillation time (-2.5% for the basic blend) was attenuated (-0.6%) by using composite blends; the thickness of the semicoke and plastic zone increased with increasing coalescence times; and high temperature mechanical properties improved as a result of charge density increase. 15 refs., 28 figs., 22 tabs.

50289 (EUR–12352-FR) **Post-cracking of volatile matter from coal carbonization.** Centre de Pyrolyse de Marienau, 57 (France). 1990. 184p. (In French). Source: Commission of the European Communities, Luxembourg.

Direct post-cracking of volatile matter from coal carbonization has been studied at laboratory, pilot and full scale. The effects of process variables (temperature, residence time, coal composition...) on the yields and the chemical composition of products were investigated. The cracking of volatile matter was measured by severity indexes for each product. H_2/CnHm and % CO for the gas; Benzene/Benzene + toluene + xylenes for the benzols; selective extraction, Naphthalene/Me Naphthalene, different types of THF-I for the tars; analysis of carbon deposits (carbon black, pyrolytic carbon...). These indexes are similar to the severity indexes used in the oil industry (naphtha - steam cracking) and can characterize the cracking level of volatile matter in the coke oven.

50290 (EUR–12628-FR) **Hydropyrolysis of coals under pressure: influence of coal pretreatment on the hydropyrolysis yields and mechanisms.** Cypres, R. Universite Libre de Bruxelles (Belgium). 1990. 89p. Source: Commission of the European Communities, Luxembourg.

During the 1987-1989 period, studies on hydropyrolysis of coal have been continued. The influence of various pretreatments, catalytic or not, on the hydropyrolysis yields has been investigated. Several gaseous pretreatments (H_2, He, CO_2, H_2O, H_2S/H_2) have shown that a H_2 pretreatment slightly increases the oil yield and improves its quality, whereas He, CO_2 and steam have a negative influence. 5% H_2S in H_2 increases the rate of oil formation. Addition of 1% of MoS_2 is particularly advantageous when hydropyrolysis is performed at relatively low temperature (500°C). Electrochemical pretreatment of the coal is also under investigation. Preliminary experiments have determined the conditions leading to a significant improvement of the pyridine extraction yields. The study of the characteristics of the chars has been continued. The evolution of the porosity, the microhardness, the exinite reflectance and fluorescence during coal pyrolysis under He and H_2 pressure have shown the role of H_2 during the first step of the devolatilization. Oxy- and carboxyreactivities in fixed and fluidized beds have been studied, showing the importance of the pyrolysis condition on the combustion rates. The study of the hydrocracking of a phenolic fraction has been completed. The best conditions for on-line postcracking have been determined, leading to a chemical upgrading of the pyrolysis oil. The study of the fate of organic sulfur under pyrolysis and hydropyrolysis conditions has been completed. The cracking mechanisms of the thiophenic compounds under H_2 pressure have been demonstrated. 18 refs., 32 figs., 21 tabs.

50291 (EUR–12644-FR) **Studies of the processes of coal utilisation and conversion.** Centre d'Etudes et Recherches des

Charbonnages de France (CERCHAR), 92 - Rueil-Malmaison (France). 1990. 123p. (In French). Source: Commission of the European Communities, Luxembourg.

Interactions between solid fuels (coals, char) and bituminous-type binding materials (coal tar pitch, heavy residues from oil processing) are of interest in briquetting, pelletisation, and extrusion for industrial or domestic applications and in the production of composite matrices of carbon-type materials, e.g. electrodes. This report describes 3 separate studies aimed at increasing our knowledge of these interactions. In the first study, a kneading type rheometer and a pseudo inert component (petroleum calcined coke as representative of chars) were used to investigate the behaviour of blends based on different bituminous components. The second study examined the penetration of melted pitch into solid coal or char. The mechanical stresses involved in the production of formed products of char and binder (such as electrodes) are known to introduce anisotopes, therefore the study also investigated the preferred orientations of fibrous textures in calcined cylindrical samples, and the electrical resistivity anisotropy. Study 3 involved a thermogravimetric investigation of coal gasification carried out under conditions simulating those of industrial gasification - temperature up to 1130°C, pressure up to 70 bars - and different gaseous atmospheres (H_2; H_2O; CO_2; N_2etc.). The combustion curves are described and a reactivity index given.

50292 (IS-T–1455) **Precipitation of jarosite-type double salts from spent acid solutions from a chemical coal cleaning process.** Norton, G. Ames Lab., IA (USA). 21 Sep 1990. 124p. Sponsored by U.S. DOE Fossil Energy; U.S. Department of the Interior. DOE Contract W-7405-ENG-82. Grant G1194119. Order Number DE91000744. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The precipitation of jarosite compounds to remove Na, K, Fe, and SO_4^{2-} impurities from spent acid solutions from a chemical coal cleaning process was studied. Simple heating of model solutions containing $Fe_2(SO_4)_3$, Na_2SO_4, and K_2SO_4 caused jarosite ($KFe_3(SO_4)_2(OH)_6$) to form preferentially to natrojarosite ($NaFe_3(SO_4)_2(OH)_6$). Virtually all of the K, about 90% of the Fe, and about 30% of the SO_4^{2-} could be precipitated from those solutions at 95°C, while little or no Na was removed. However, simple heating of model solutions containing only $Fe_2(SO_4)_3$ and Na_2SO_4 up to 95°C for $\leq$12 hours produced low yields of jarosite compounds, and the Fe concentration in the solution had to be increased to avoid the formation of undesirable Fe compounds. Precipitate yields could be increased dramatically in model solutions of $Na_2SO_4/Fe_2(SO_4)_3$ containing excess Fe by using either $CaCO_3$, $Ca(OH)_2$, or ZnO to neutralize H_2SO_4 released during hydrolysis of the $Fe_2(SO_4)_3$ and during the precipitation reactions. Results obtained from the studies with model solutions were applied to spent acids produced during laboratory countercurrent washing of coal which had been leached with a molten NaOH/KOH mixture. Results indicated that jarosite compounds can be precipitated effectively from spent acid solutions by heating for 6 hours at 80°C while maintaining a pH of about 1.5 using $CaCO_3$.

50293 (NZERDC-P–127) **Solvent extraction of South Island lignites: separation and characterisation of some organic chemical components.** Grimmett, M.R.; Vickers, M. New Zealand Energy Research and Development Committee, Auckland (New Zealand). Nov 1987. 46p. Source: Ministry of Commerce, Energy and Resources Division, P.O. Box 2337, Wellington, New Zealand.

A number of South Island lignite samples have been subjected to solvent extraction in order to separate and identify some of the organic compounds present in the coals. Following a survey of the extraction efficiencies of several solvents, the mixture of toluene, ethanol and water was chosen as the most suitable. Moisture content of the coals appears to have only minor effect on the efficiency of such extractions. Problems which have arisen during the soxhlet extraction processes have been addressed. Fractionation of the crude extracts using other solvents allows separation into true waxes, resins and asphalts. Further analysis of the true wax fraction has utilized adsorption chromatography, infrared and proton magnetic resonance spectroscopy. Among these subsequent fractions is one consisting largely of alkanes, some of which have been identified by gas chromatographic techniques. The wax ester fraction from the separation has been examined by way of methylation. Preliminary efforts have been applied to the characterization of the more polar fractions resulting from the chromatographic separation. A considerable proportion of the project has been devoted to the problems of obtaining a coal sample which has a known mass and water content, which is in a suitable state for extraction, which has not been modified chemically between the mine and the laboratory, and which is at least moderately representative. The major value of the project to date has been the development of techniques, expertise and experience required to provide scientifically significant information about so heterogeneous material as lignite. 37 refs., 9 figs., 7 tabs.

50294 (SAND–90-2198C) **Use of metal hydrous titanium oxide catalysts to enhance coal tar yield via hydropyrolysis.** Klavetter, E.A.; Stephens, H.P.; Dosch, R.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. (CONF-900982–1: Direct liquefaction contractors review, Pittsburgh, PA (USA), 24-27 Sep 1990). Order Number DE91000406. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Catalytic hydropyrolysis experiments performed in this project on several US and UK coals have established that tar yields in excess of 70% (daf basis) and conversions (100%-char) in excess of 80% can be achieved from bituminous coals containing 80–84% dmmf carbon using hydrous titanium oxide (HTO) catalysts with low concentrations of active metals. Total conversion approaches the reactive maceral contents for these coals. Previously performed two-stage catalytic hydropyrolysis experiments have demonstrated that high yields of liquid products with high H/C ratios, low heteroatom contents, and a significant concentration of light naphtha can be achieved. The objectives of this research are to determine suitable methods for catalyzing the hydropyrolysis process and to investigate the reactions and mechanisms responsible for the high conversion of coal materials to distillable liquids via direct catalytic hydropyrolysis. Recently developed hydrous titanium oxide (HTO)-supported catalysts have received encouraging results in direct coal liquefaction applications. Results of hydropyrolysis experiment using Mo and Pd HTO catalysts coated directly onto the coal are presented here and compared with results from experiments using uncatalyzed coal samples and using a dispersed MoS_2 catalyst. The effect of coal rank, active metals concentration, dispersion method, and metal type are discussed. 9 refs., 6 figs., 2 tabs.

50295 (UCRL-JC–104514) **Mild coal gasification screw pyrolyzer development and design.** Camp, D.W. Lawrence Livermore National Lab., CA (USA). Aug 1990. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. (CONF-900853–4: Gasification and gas stream cleanup systems, Morgantown, WV (USA), 28-30 Aug 1990). Order Number DE91000816. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our objective is to produce information and design recommendations needed for the development of an efficient continuous process for the mild gasification of caking bituminous coals. We have focused on the development of an externally heated pyrolyzer in which the sticky, reacting coal is conveyed by one or more screws. We have taken a multifaceted approach to forwarding the development of the externally-heated screw pyrolyzer. Small scale process experiments on a 38-mm single screw pyrolyzer have been a major part of our effort. Engineering analyses aimed at producing design and scaleup equations have also been important. Process design recommendations follow from these. We critically review our experimental data and experience, and information from the literature and equipment manufactures for the purpose of making qualitative recommendations for improving practical pyrolyzer design and operation. Benchscale experiments are used to supply needed data and test some preliminary concepts. 6 refs., 4 figs., 1 tab.

50296 **In situ chemical trapping of CO/H_2 surface species.** Cavalcanti, F.A.P. (Univ. of Pittsburgh, PA (USA)); Blackmond, D.G.; Oukaci, R.; Sayari, A.; Erdem-Senatalar, A.; Wender, I. *Journal of Catalysis (USA)*, 113(1): 1-12 (Sep 1988).

CO hydrogenation reactions over RuKY catalysts were monitored in situ using a novel chemical trapping technique to identify surface species. Study of alterations in the product distribution upon addition of the trapping agent led to a good prediction of the type of

reactive surface species thought to be present on the surface of these catalysts. This work represents the first evidence that this chemical trapping technique selectively traps active surface intermediate species. A number of other significant changes in the surface chemistry of the catalysts occurred upon addition of the trapping agent, indicating that the action of the trapping agent appears to be more complex than had previously been suggested. Although these results have uncovered interesting and revealing phenomena, it is evident that additional investigations are needed before the full value and import of this technique as a means of identifying reactive surface species can be fully assesses. 35 refs.

50297 Deuterium exchange of benzo[b]thiophene: Model complex and heterogeneous reactor studies. Huckett, S.C. (Iowa State Univ., Ames (USA)); Angelici, R.J.; Ekman, M.E.; Schrader, G.L. *Journal of Catalysis (USA)*, 113(1): 36-44 (Sep 1988). DOE Contract W-7405-ENG-82.

The complexes $[CpRu(BT)]^+$ and $[CpRu(3\text{-}MeBT)]^+$, where BT is benzo[b]thiophene and 3-MeBT is its 3-methyl derivative, are models for π-coordination of BT to hydrodesulfurization (HDS) catalysts via the benzene ring. The BT in these complexes undergoes base-catalyzed deuterium exchange, at the 2 and 7 positions; in KOH/CD_3OD solutions, the exchange follows the rate law: rate = k[Ru complex][OH^-]. The mechanism is proposed to involve rate-determining proton abstraction by OH^- from either $[CpRu(BT)]^+$ or $[CpRu(BT)]^+$ followed by transfer of D^+ from the CD_3OD solvent to give the deuterated BT complex. Heterogeneous reactor studies of deuterium exchange of BT with D_2 over several HDS catalysts ($PbMo_{6.2}S_8$, $Co_{0.25}MoS$, and 5% $Re/\gamma\text{-}Al_2O_3$) and $\gamma\text{-}Al_2O_3$ indicate that BT is activated to exchange at the 2 and 3 positions over the catalysts. These results suggest that deuterium exchange of BT over HDS catalysts may occur through routes other than those involving BT π-bonding through its benzene ring to the catalyst surface.

50298 Metal-support effects on acetone hydrogenation over platinum catalysts. Sen, B. (Pennsylvania State Univ., University Park (USA)); Vannice, M.A. *Journal of Catalysis (USA)*, 113(1): 52-71 (Sep 1988). DOE Contract FG02-84ER13276.

Acetone hydrogenation was studied over Pt/TiO_2, $Pt/\eta\text{-}Al_2O_3$, Pt/SiO_2, Pt powder, and Pt/Au catalysts to test the hypothesis that the metal-support effect responsible for higher CO hydrogenation rates over certain metal/TiO_2 catalysts represents a phenomenon capable of activating carbonyl bonds in general. Compared with the other catalysts, the high-temperature reduced (HTR) Pt/TiO_2 samples had turnover frequencies more than 500 times higher than those of unsupported Pt and Pt/SiO_2 catalysts, and the specific activity (per g Pt) of the Pt/TiO_2 catalyst was 10 times that of a Pt/SiO_2 catalyst with comparable dispersion. Complete hydrogenation to C_3H_8 and H_2O occurred only on large, unsupported Pt crystallites; however, partial hydrogenation to isopropyl alcohol appeared to be structure insensitive and activation energies were similar over all catalysts, as were pressure dependencies, which associates the higher activity with a larger preexponential factor. Only one Langmuir-Hinshelwood model provided a rate expression consistent with experimental results - that which assumed competitive adsorption of H_2 and acetone on the same sites and addition of the second H atom as the rate-determining step. This model is consistent with previous TPD, IR, and EELs studies and is also substantiated by theoretical calculations based on the bond-order conservation method. The much higher activities over Pt/TiO_2 catalysts are attributed to an increase in the active site concentration in the Pt-titania interface region. These special sites are presumed to be defects on the titania surface near the Pt that can activate the carbonyl bond in the presence of atomic hydrogen provided by the Pt. 131 refs.

50299 Secondary reactions on metal-zeolite catalysts used in synthesis gas conversion. Gormley, R.J.; Rao, V.U.S.; Anderson, R.R.; Schehl, R.R.; Chi, R.D.H. *Journal of Catalysis (USA)*, 113(1): 193-205 (Sep 1988).

The mechanism of synthesis gas conversion over cobalt-ZSM-5 catalysts to gasoline-range hydrocarbons has been examined. A correlation exists between the methane yield and the percentage aromatics in the liquid hydrocarbon product. This could be due to heat transfer effects or to the hydrogenolysis of propane and butane over cobalt, leading to the formation of additional methane. The formation of additional alkanes (propane and butane) is known to accompany the aromatization process. The percentage of methane made by the bifunctional catalyst 4.2% Co/SiO_2 + ZSM-5 was 1.7 times that made by the Co/SiO_2 catalyst with a feed of H_2/CO = 1 at 280°C, 21 atm, and WHSV = 0.77. An attempt was made to inhibit secondary hydrogenolysis reactions by the addition of copper to the cobalt catalyst. Under similar process conditions, this provided a very small help in keeping down the increase in percentage of methane upon the addition of ZSM-5. Addition of 5 and 10% propane to the synthesis gas showed no additional methane made by hydrogenolysis. If needed some of the methane produced over cobalt-ZSM-5 catalysts is coming from hydrogenolysis of light alkanes, it is a small amount.

50300 Surface and bulk changes in iron nitride catalysts in H_2/CO mixtures. Hummel, A.A. (Purdue Univ., West Lafayette, IN (USA)); Wilson, A.P.; Delgass, W.N. *Journal of Catalysis (USA)*, 113(1): 236-249 (Sep 1988). DOE Contract FG22-82PC50804.

Preparation of the ζ, ϵ, and γ'-iron nitride phases was confirmed by Moessbauer spectroscopy, X-ray diffraction, and quantitative mass spectrometry of NH_3 evolved during decomposition. Computer fitting of the ϵ-nitride Moessbauer spectra with a distribution of hyperfine fields shows the conversion of iron with two nitrogen nearest neighbors (Fe 2nn) to Fe 3nn as the nitrogen content increases. The dynamic response of the nitrides to H_2/CO mixtures at reaction temperatures was followed by constant-velocity Moessbuaer spectroscopy and transient mass spectrometry. The rapid decomposition of the iron nitrides in H_2 at 523 K occurs with surface reaction as the rate-limiting step, initially. At lower temperatures or after significant nitride decomposition, the data are best fit with a shrinking core model. For reaction at 473 K, the Moessbauer effect identified an α-Fe shell, a $\zeta\text{-}Fe_2N$ core, and an $\epsilon\text{-}Fe_xN$ transition region. Surprisingly, loss of the pure nitride phase is barely retarded for H_2/CO mixtures compared to H_2 alone at 523 K. Mass spectrometric studies show that the freshly prepared nitride has a substantial hydrogen inventory, equivalent to a monolayer of NH_3 for $\zeta\text{-}Fe_2N$. On exposure to synthesis gas, the nitride catalysts produce no methane until one to two monolayers of N have been removed, but carbon is deposited on the catalysts by the Boudouard reaction. Mass spectral measurements show no evidence for active nitrogen on the surface after the synthesis reaction has been established. Both Moessbauer spectroscopy and mass spectral measurement confirm, however, that following the initial loss of nitrogen, bulk carbonitrides form which lose their nitrogen very slowly as the reaction proceeds. 28 refs.

50301 Analysis of CO hydrogenation pathways using the bond-order-conservation method. Shustorovich, E. (Eastman Kodak Co., Rochester, NY (USA)); Bell, A.T. *Journal of Catalysis (USA)*, 113(2): 341-352 (Oct 1988). DOE Contract AC03-76SF00098.

The bond-order-conservation (BOC) method has been used to identify the energetics associated with the hydrogenation of CO over (111) surfaces of Ni, Pd, and Pt. In the formation of CH_4, the C-O bond of CO is cleaved. BOC calculations for Ni indicate that cleavage of the C-O bond occurs primarily by direct dissociation of molecularly adsorbed CO. The activation energy for direct dissociation of CO on Pd and Pt is significantly greater than that for hydrogen assisted dissociation, and hence the latter process is more significant. The BOC calculations indicate that for these metals the species from which C-O bond cleavage occurs is CH_3O_5. Because the activation barriers for CH_3O_5 dissociation and hydrogenation to form CH_3OH are close for Pd and Pt, these metals are effective catalysts for both CH_4 and CH_3OH synthesis. By contrast, the BOC method predicts that CH_4 should be the principal product formed over Ni. 36 refs.

50302 Methanol and C_2 oxygenate synthesis over cesium doped Cu/ZnO and $Cu/ZnO/Al_2O_3$ catalysts: A study of selectivity and ^{13}C incorporation patterns. Nunan, J.G. (Lehigh Univ., Bethlehem, PA (USA)); Bogdan, C.E.; Klier, K.; Smith, K.J.; Young, Chyiwooi; Herman, R.G. *Journal of Catalysis (USA)*, 113(2): 410-433 (Oct 1988).

Cesium formate significantly promotes methanol and C_2 oxygenate (methyl formate MF and ethanol EtOH) synthesis over the Cu/ZnO catalyst. ^{13}C NMR analysis of the product obtained from $^{13}CH_3OH$ and $^{12}CO/H_2$ shows that MF is formed by direct carbonylation of methanol and EtOH is formed by coupling of oxygenated C_1 intermediates originating from methanol. The C_1 coupling mechanism overrides various CO insertion paths to ethanol over the present Cs/Cu/ZnO catalyst. The kinetic significance of C_1 aldehydic species such as adsorbed formyl and formaldehyde is supported by experimental evidence and theoretical calculations. 71 refs.

50303 The origin of the support effect in MgO-supported catalysts. Logan, A.D. (Univ. of New Mexico, Albuquerque (USA)); Datye, A.K. *Journal of Catalysis (USA)*, 112(2): 595-598 (Aug 1988).

MgO is an interesting catalyst support due to its ability to stabilize the metal in unusual oxidation states and to prevent sintering and volatilization. However, there are numerous examples where the reactivity of the metal is adversely affected when supported on MgO. In the CO hydrogenation reaction, MgO-supported catalysts exhibit a greater selectivity to long-chained hydrocarbons than SiO_2-supported catalysts. While this selectivity behavior is similar to that seen on TiO_2 supports, unlike on TiO_2 it is accompanied by a lower reactivity. The unusual properties of TiO_2-supported catalysts are believed to be caused by decoration of the metal surface by TiO_x derived from the support and local electronic perturbation, but the origin of the MgO support effect is not well understood. A number of possible explanations have been proposed to explain support effects. These are the following: (i) alteration of the morphology and surface structure of the metal crystallites by the support, (ii) decoration of the metal surface by species derived from the support, and (III) electron transfer between the metal and the support leading to altered chemisorptive and catalytic properties for the metal. In this paper, the authors report their observations on the influence of aqueous versus nonaqueous impregnation on the selectivity of supported Ru in the CO hydrogenation reaction.

0105 Products and By-Products

Refer also to citation(s) 50291

50304 (EUR–12652-EN) **Development of an alkali-resistant coke.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1990. 74p. Source: Commission of the European Communities, Luxembourg.

Using CRE-developed bulk test procedures, coke containing deposited potassium carbonate were exposed to temperatures up to 1400°C in various nitrogen/carbon dioxide gas mixtures. It was established that structural weakening of coke caused by potassium does take place at gas compositions containing less than 5-10% carbon dioxide. At higher carbon dioxide concentrations direct interaction is prevented and coke loses strength solely by catalytic gasification. In order to maximise the strength of coke in the bosh region of the furnace an important (and obvious) step is to select coals of low alkali content in order to help reduce the alkali loading to the furnace. There are also possibilities of increasing the alkali resistance of the coke by adding fine minerals to the coking charge or by including in blend formulation a selection procedure which gives consideration to preferred mineral compositions of coals. It is also to be noted that improvements in alkali resistance are given by prior exposure to high temperatures and by the presence of carbon dioxide (particularly concentrations above 5-10%). Thus coke's effective alkali resistance in the blast furnace would be improved by maximisation of these conditions.

0106 Properties and Composition

Refer also to citation(s) 50258, 50259, 50260, 50270, 50293, 50304

50305 (CONF-900802–9) **Growth and status of the Argonne Premium Coal Sample Program.** Vorres, K.S. Argonne National Lab., IL (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 200. American Chemical Society national meeting; Washington, DC (USA); 26-31 Aug 1990. Order Number DE90017803. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Argonne Premium Coal Sample Program (APCSP) was established to provide samples to the basic coal research scientific community. The quality of these samples is intended to be the best that can be devised and implemented. Samples of eight US coals have been selected, collected, processed and packaged, analyzed and distributed. Information has been disseminated through Symposia, Quarterly Newsletters, and a Users Handbook. The number of publications is now about 1 for each two shipments of coal samples, and is approaching 200.

50306 (CONF-900981–1) **Advanced research in instrumentation and control technology.** Sheen, S.H.; Raptis, A.C. Argonne National Lab., IL (USA). Sep 1990. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Contract AA-15-20-25. From Advanced research and technology development contractors review; Pittsburgh, PA (USA); 16-19 Sep 1990. Order Number DE90017823. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The project objective is to conduct advanced research in instrumentation and diagnostics technology needed in coal combustion and conversion processes. The programmatic objective of this reporting period is to evaluate ultrasonic methods for measuring fluid viscosity and to develop an on-line ultrasonic rheological instrument that may be used to monitor of coal slurries in coal processes. Results are discussed. 15 refs., 9 figs.

50307 (DOE/PC/79907–T7) **Spectroscopic study of coal structure and reactivity: Quarterly report, September 15, 1989–December 14, 1989.** Rabenstein, D.L. California Univ., Riverside, CA (USA). Dept. of Chemistry. 7 Sep 1990. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79907. Order Number DE91000635. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The aim of this project is to perform quantitative analysis of the Fourier transform infrared (FT-IR) spectra of coals and coal extracts. The major difficulty encountered in the analysis of the FT-IR spectra of coals is the complexity of the bands, which consist of many closely overlapped peaks. Two techniques that are commonly used for the quantitative analysis of complex FT-IR spectra are deconvolution and curve-fitting. Deconvolution is a mathematical technique that narrows the speaks in a spectrum, thereby improving the effective resolution. Curve-fitting optimizes a set of ban parameters, using a least squares criterion, to simulate the true spectrum. We have recently completed work on optimizing the combination of these two techniques with the aim of applying this to the spectra of coals and coal extracts. Two types of deconvolution were investigated in this context: Fourier self-deconvolution (FSD) and maximum likelihood restoration (MLR). It was concluded that for noisy spectra MLR gave superior results. 3 refs., 7 figs.

50308 (DOE/PC/79907–T8) **Spectroscopic study of coal structure and reactivity: Quarterly report, December 15, 1989–March 14, 1990.** Rabenstein, D.L. California Univ., Riverside, CA (USA). Dept. of Chemistry. 7 Sep 1990. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79907. Order Number DE91000634. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Work done during this period (December 15, 1989 to March 14, 1990) covered two of the three primary areas of study of this project. The first involved the continuing development a of step-scanning interferometer for the photoacoustic depth-profiling of materials whose composition varies in the spatial region between 5 and 50 μm from its surface. The second covered the initial construction of an on-line interface between a supercritical fluid chromatograph (SFC) and a Fourier transform infrared (FT-IR) spectrometer for monitoring the composition of coal extracts. 5 refs., 8 figs.

50309 (DOE/PC/79913–T4) **A novel method of atomizing coal-water slurry fuels: Final report.** Sojka, P.E.; Lefebvre, A.H. Purdue Univ., Lafayette, IN (USA). Thermal Sciences and Propulsion Center. May 1990. 116p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79913. Order Number DE91000001. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Despite the body of work describing the performance of effervescent atomizers, its potential for use with coal water slurries (CWS) had not been evaluated prior to this study. This program was therefore undertaken: to demonstrate that effervescent atomization can produce CWS sprays with mean drop sizes below 50μm; to determine a lower size limit for effervescent atomizer produced CWS sprays; to determine the mechanism(s) responsible for the formation of effervescent atomizer produced sprays. An analysis of the effects of slurry rheological properties (as indicated by the consistency index and the flow behavior index) and formulation (in terms of loading and coal particle top size) on the spray formation process was performed. The experimental data reported were then analyzed to explain the physical processes responsible for spray formation. The analysis began by considering an energy balance across a control volume that extended from the nozzle exit plant to the line of spray measurement. The inlet conditions were calculated using two-phase flow techniques and the outlet conditions were calculated by using conservation of momentum and assuming that the final velocities of the air and liquid were equal. Entrainment was considered negligible and losses were accounted for by realizing that only a small fraction of the atomizing air participated in the spray formation process with the remainder passing through the control volume unperturbed. Results are discussed. 41 figs., 4 tabs.

50310 (DOE/PC/79925–8) **Chemical characterization of the surface sites of coal: Technical progress report, July–September 1989.** Fowkes, F.M.; Kardos, K.; Riddle, F.L. Jr.; Cole, D.A. Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry. Aug 1990. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79925. Order Number DE91000639. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We propose to do experimental studies in four related areas concerning the acid-base properties of coal surfaces: (1) develop high precision flow microcalorimetric methods for determining the concentrations and strengths of the acidic and basic surface sites of coal powders: (2) develop photo-acoustic FTIR and solid-state NMR spectral shift techniques for determination of the concentrations and strengths of acidic and basic surface sites of coal powders; (3) determine the concentrations and strengths of the acidic and basic surface sites of some of the well-characterized coal samples from Argonne National Labs., comparing the coal samples before and after demineralization treatments with HCl and HF; (4) study the effects of surface acidity and basicity on the coal/water interface, with emphasis on the role of interfacial acid-base interactions in the adsorption of ions, surfactants and coal/water slurry stabilizers. From measured heats of interaction, a reasonable estimate can be made of the most prevalent functional groups in coal. This quarter, heats of adsorption of phenols and pyridines were investigated. 2 tabs. (CBS)

50311 (DOE/PC/79925–9) **Chemical characterization of the surface sites of coal: Technical progress report, October–December 1989.** Fowkes, F.M.; Riddle, F.L. Jr.; Cole, D.A. Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry. Aug 1990. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79925. Order Number DE91000637. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We propose to do experimental studies in four related areas concerning the acid-base properties of coal surfaces; (1) develop high precision flow microcalorimetric methods for determining the concentrations and strengths of the acidic and basic surface sites of coal powders; (2) develop photo-acoustic FTIR and solid-state NMR spectral shift techniques for determination of the concentrations and strengths of acidic and basic surface sites of coal powders; (3) determine the concentrations and strengths of the acidic and basic surface sites of some of the well-characterized coal samples from Argonne National Labs, comparing the coal samples before and after demineralization treatments with HCl and HF; (4) study the effects of surface acidity and basicity on the coal/water interface, with emphasis on the role of interfacial acid-base interactions in the adsorption of ions, surfactants and coal/water slurry stabilizers. One of the major goals of this research effort is to identify and characterize acidic and basic molecules which have NMR active nuclei such that through measurements of NMR chemical shifts one can deduce the surface acidity or basicity of solids such as coals. This quarter, triphenylsilanol was investigated as an NMR chemical shift probe molecule. 2 figs., 1 tab.

50312 (DOE/PC/80522–T8) **Metal arene complexes in coal structure determination: Final report.** Woolsey, N.F. North Dakota Univ., Grand Forks, ND (USA). Dept. of Chemistry. Jul 1990. 34p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80522. Order Number DE90016802. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The utility of metal arene complexes (arene-$M(CO)_3$) (M=Cr,Fe) and some iridium complexes in the cleavage reactions designed to remove aliphatic groups from aromatic rings was studied. It was found possible to prepare chromiumtricarbonyl complexes of polymers and in one case of a coal. The model polymer complexes alkylated satisfactorily on the benzylic carbon. A large number of methods were examined to functionalize the benzylic carbon on monomeric complexes in a way which would facilitate cleavage. Both hydroxylation and amination were carried out (the latter with iron complexes) but not adequately for application to coals. Oxamination also appeared promising. Catalytic cleavage reactions either by initial nucleophilic, ipso attack followed by insertion or by direct insertion were not observed. The rodium complexes showed simple complex formation or carbon-hydrogen insertion rather than the desired carbon-carbon insertion reaction. 34 refs., 6 tabs.

50313 (DOE/PC/80529–T14) **Effects of coal structure on pulverized coal conversion processes: Final report, October 1, 1985–August 31, 1989.** Wells, W.F.; Smoot, L.D. Brigham Young Univ., Provo, UT (USA). Combustion Lab. 30 Nov 1989. 274p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80529. Order Number DE90016754. Source: NTIS, PC A13/MF A01 - OSTI; GPO Dep.

This document summarizes research accomplishments of a forty-seven month study of the effects of coal structure on pulverized coal conversion processes. The objective of this study was to determine the causal relations between the physical and chemical properties and high temperature reaction characteristics of three coals of different rank (North Dakota Beulah-Zap lignite, Wyoming Wyodak subbituminous, and Utah Schofield bituminous) and chars derived from these coals. Chars were prepared from two size-graded fractions of the parent coal. Fuels prepared were: (1) untreated coal (virgin coal), (2) char prepared by extraction in pyridine (extract char), and (3) char prepared by pyrolysis at high temperature in an inert atmosphere (pyrolysis char). Fifty different types of measurements were made to characterize the fuel chemical and physical properties. The virgin coals and prepared chars were reacted in air at three gas temperatures (1073, 1173, and 1273 K) and at three residence times (20, 25, and 30 ms). Advanced statistical correlative methods were used to analyze the fuel properties data and determine the statistical significance of the observed trends. Correlative analysis was performed to determine relationships among: (1) physical and chemical properties of the fuels, (2) physical and chemical properties of the virgin coals with those of the chars and char yield, and (3) physical and chemical properties of the fuels and their reaction rates. Comparison of the observed correlations with theory and the experimental work of others allowed the determination of several causal relations. 176 refs., 57 figs., 20 tabs.

50314 (DOE/PC/88912–T5) **Roles of additives and surface control in slurry atomization: Quarterly report, July–September 1990.** Tsai, S.C. California State Univ., Long Beach, CA (USA). [1990]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88912. Order Number DE91000849. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Objectives: of this projects are to: promote further understanding of the mechanisms and the roles of additives in airblast atomization of coal water slurry (CWS); and investigate the impacts of coal particle surface properties and interparticle forces on CWS rheology and coal cleanability. This study covers rheology and airblast atomization of micronized coal water slurry. Airblast atomization is carried out in a bench scale unit equipped with a twin-fluid jet atomizer and a Malvern Particle Sizer 2600C for drop size measurement. The coal water slurries are composed of 0.40 to 0.47

volume fractions of micronized 4.4 μm Upper Freeport coal and micronized 3.7 μm Illinois #6 in aqueous solutions containing 20% to 80% glycerol, 42% ethylene glycol, or 50% isopropanol. 2 figs., 2 tabs.

50315 (DOE/PC/88924–7) **Thermodynamics of the solvent swelling of coal: Technical progress report No. 7, March 1, 1990–May 31, 1990.** Green, T.K. Western Kentucky Univ., Bowling Green, KY (USA). Center for Coal Science. [1990]. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88924. Order Number DE91000853. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sorption of pyridine by the pyridine-extracts of three premium Argonne coals was studied at several relative vapor pressures at 50°C. The amount of pyridine sorbed by each extract increases linearly with pyridine vapor pressure. The extrapolated lines do not pass through the origin. At low pressures, a dual-mode sorption mechanism is proposed, whereby pyridine concurrently fills holes (microvoids) and dissolves into the extract. At higher pressures, we propose that the holes are saturated and that only dissolution is occurring. Dissolution thus increases linearly with pressure of pyridine. Not all pyridine can be desorbed from the extract. The amount remaining corresponds closely to the intercept of the straight-line curve. This result suggests that pyridine cannot be desorbed from the holes at the experimental temperature. 1 ref., 4 figs., 1 tab.

50316 (DOE/PC/88924–8) **Thermodynamics of the solvent swelling of coal: Technical progress report No. 8, June 1, 1990–August 31, 1990.** Green, T.K. Western Kentucky Univ., Bowling Green, KY (USA). Center for Coal Science. [1990]. 23p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88924. Order Number DE91000854. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sorption of pyridine by the pyridine-extracts of three premium Argonne coals was studied at several relative vapor pressures at 50°C and 70°C. The amount of pyridine sorbed by each extract increases linearly with pyridine vapor pressure. Heat of dilution were calculated from the slopes of the straight-line portions of the curves. In a related experiment, the pyridine sorption isotherms of the pyridine-extract, pyridine-insoluble residue, and the whole coal were determined at 50°C. For all materials, the amount of pyridine sorbed increases linearly with pressure of pyridine, with similar slopes. However, the intercepts are different for each material. Finally, the sorption of benzene vapors by O-alkylated Illinois #6 coals were studied at 30°C. The rate of benzene sorption increases dramatically upon O-methylation, indicating that coal-coal hydrogen bonds play a dominant role in controlling the rate of benzene sorption. 2 refs., 3 figs., 1 tab.

50317 (DOE/PC/90504–T16) **Configurational diffusion of coal macromolecules: Quarterly progress report, June 16, 1990–September 15, 1990.** Guin, J.A.; Curtis, C.W.; Tarrer, A.R. Auburn Univ., AL (USA). Coal Conversion Lab. [1990]. 27p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90504. Order Number DE91000010. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this project is to investigate the phenomenon of hindered diffusion of coal macromolecules in idealized porous media. Tasks towards this objective include: Construct a diffusion cell with ideal pore structure for determination of diffusion coefficients, prepare and characterize ideal porous membranes, perform model compound experiments to calibrate and test diffusion apparatus and methodology, prepare and characterize coal macromolecules, and analyze data to evaluate the diffusional behavior of coal macromolecules. This report describes work on the hindered diffusion of tetraphenylporphine and asphaltene. 18 refs., 3 figs., 4 tabs.

50318 (DOE/PC/90532–15) **Studies of coal structure using carbene chemistry: Final report, September 15, 1986–June 14, 1990.** Texas Univ., Arlington, TX (USA). Dept. of Chemistry. [1990]. 27p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90532. Order Number DE91000590. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The object of this grant was to react coal, derivatized forms of coal, and solvent swelled coal with carbenes (divalent carbon species) under mild conditions. These carbenes were to be prepared by treating the coal with several diazo compounds and then thermally decomposing them at relatively low temperatures (80–130°C). The carbenes were to be chosen to show varying selectively toward aromatic rings containing heteroatom functionalities and toward polynuclear aromatic systems. In some instances, where selectivities toward aromatic and heteroaromatic ring systems were not known, model studies were to be carried out. Because of the generally mild conditions employed and the good selectivity anticipated, and actually observed with one particular system, it was expected that this methodology would provide structural information about the coal, along with data on the extent of occurrence and type of aromatic systems. After carbene reactions, treatment of the coal samples was to include extractions and thermolysis. Physical studies included thermogravimetric analysis, diffuse reflectance FT-IR spectroscopy, NMR (^{1}H and ^{13}C) spectroscopy, gas chromatography, GC/MS and GC/FT-IR. 7 figs., 10 tabs.

50319 (EPRI-ER–6572, pp. 1.1-1.14) **Characterization of inorganic constituents and heteroatoms in coal by advanced analytical techniques.** Huffman, G.P. (Univ. of Kentucky, Lexington (USA)); Shah, N.; Huggins, F. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

An overview is presented of the use of advanced analytical techniques for determination of the molecular structure, microstructure, and amounts of the inorganic constituents and impurity elements in coal. Because of high current interest in biodesulfurization, emphasis will be placed on analysis of sulfur forms. Mossbauer spectroscopy is the best technique available for quantitative analysis of the iron-bearing phases in a complex sample, and it is therefore ideal for determination of the oxidative or other transformations of pyrite. The reactions of pyrite during microbial treatment are highly sensitive to its size distribution and degree of inclusion in macerals which can best be determined by computer-controlled scanning electron microscopy (CCSEM). X-ray absorption fine structure (XAFS) spectroscopy has recently been shown to be an excellent method for determining the molecular structure of organic and other forms of sulfur. Electron microprobe and CCSEM techniques can also be used for direct measurement of organic sulfur content. Results obtained by applying these three techniques to biotreated coals are summarized.

50320 (EPRI-ER–6572, pp. 1.15-1.36) **Macromolecular structure of coal.** Hippo, E.J. (Southern Illinois Univ., Carbondale (USA)); Crelling, J.C.; Palmer, S.R.; Kruge, M.A. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Coal is a complex heterogeneous mixture which is difficult to sample and characterize. An understanding of the complex physical and chemical properties of coal is required to develop methods for desulfurizing and depolymerizing coal employing bioconversion technology. This paper describes some of the basic properties of coal and discusses some of the problems associated with coal characterization and conversion. The various components of the coal are described and knowledge of the chemical structures found in coal is presented. Special attention is given to properties which might influence bioconversion processes. These include heterogeneity, pore structure, functional groups, water forms, bridging bonds and molecular size. 126 refs.

50321 (EPRI-ER–6572, pp. 1.37-1.46) **Aliphatic structural elements of bituminous coals.** Stock, L.M. (Argonne National Laboratory, IL (USA)); Choi, Cholyoo; Muntean, J.V.; Wang, Shihhsien. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17

May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The three kinds of experiments described in this brief presentation and other information published in the coal science literature provide a substantial basis for the discussion of the aliphatic components of bituminous coals. First, the solid state carbon magnetic resonance data that have been obtained by the research team at the University of Utah for coals from the Premium Sample Program at the Argonne national Laboratory confirm that the aliphatic carbon atom content is related inversely to the total carbon atom content. More important, the results are compatible with the view that they methylene group/methyl group ratios declines as the total carbon content increases. Second, extraction and reaction studies with a low rank brown coal from Australia, a bituminous coal with a high liptinite content, and a premium sample of Illinois No. 6 coal suggest that molecules with more than 15 linear methylene groups are often abundant, but are present in a diverse array of environments. Some of these methylene groups are present in linear alkanes that are readily extractable. Others occur in linear alkanes that are so deeply occluded that conventional extraction procedures fail to remove them from coal. Still others are covalently incorporated into the macromolecular structure of the coal. Third, selective oxidation reactions with ruthenium (VII) imply that liptinite macerals contain a much more diverse array of aliphatic structural fragments than the vitrinite and inertinite macerals from the same coal. When all of the information for one coal is assembled and analyzed, a realistic picture of the aliphatic constitution of coal emerges.

50322 (EPRI-ER–6572, pp. 1.63-1.69) **Low-rank coal structure from low-severity products.** Knudson, C.L. (Univ. of North Dakota, Grand Forks (USA)); Sharma, R.; Ruud, A.L. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The ChemCoal Process operates at only 350C to give over 90 wt% conversion of maf coal carbon to liquid and a clean solid product. The solid product is ash free and represents 50 wt% of the maf coal. The solid product contains 6.3 wt% hydrogen, 11.8 wt% oxygen, and 1 wt% nitrogen. Analysis indicates that carboxyl, phenolic, and aryl ethers each account for about 33% of the oxygen in the solid. Separation of the solid into methylene chloride soluble (13-19 wt% of the solid) and insoluble fractions followed by analysis indicates that the average structure of soluble material is 30 to 35-CH_2- groups in an aliphatic chain and 1 alkylated phenyl group (molecular weight of about 570-650). The insoluble material contains the oxygen and nitrogen. The average structure of this material is $H_{3.47}Naphthyl_1OH_{0.53}COOH_{0.28}Arylether_{0.86}(-CH_2-)_{1.25}$-$CH_3(-R)_2$ with a balance of the two edge positions (-R) on the naphthyl group and the arylether oxygen participating in forming soluble polymer of over 2,000 g/mol and insoluble polymer. One nitrogen atom would be present in each 1,400 g and a sulfur atom in each 14,000 g of polymer to balance the elements. Numerous analytic methods have been used to determine these average structures.

50323 (EPRI-ER–6572, pp. 1.71-1.81) **The reactive mineral-organic interface in coal.** Ross, D.S. (SRI International, Menlo Park, CA (USA)); Hirschon, A.S. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Hydrothermal treatment of coal both increases the convertibility of coal to distillate products in subsequent conversions, and enhances its yields in mild gasification. The same pretreatment changes the swelling characteristics of coal, with water itself becoming a medium in which to swell coal. A rationale for these effects can be developed with attention to the organic and mineral phases in the structure, and specifically to the interface joining the organic phase and the ultrafine mineral phase (particles <2 nm to 10 μm). The authors have evidence supporting this view in work with Illinois No. 6 coal, suggesting that the organic/mineral interface is a keys structural center for chemical reaction in what must be a crosslinked, integrated organic/mineral matrix. The evidence includes the production of hydrocarbons and phenols in hydrothermally treated coal, and the extensive introduction of deuterium in benzyl positions in the coal when the treatment is conducted in D_2O. Both findings are similar to published observations in oil shale research, where the maturation of kerogen can be accelerated in hydrothermal systems. They suggest that the ultrafine mineral/organic interface in coal may be an extensive, reactive region containing immature organic structures.

50324 (EPRI-ER–6572, pp. 3.43-3.56) **Characterization and subsequent utilization of microbially solubilized coal: Preliminary studies.** Davison, B.H. (Oak Ridge National Laboratory, TN (USA)); Nicklaus, D.M.; Woodward, C.A.; Lewis, S.N.; Faison, B.D. Electric Power Research Inst., Palo Alto, CA (USA). Dec 1989. (CONF-890582–: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). In *1989 symposium on biological processing of coal and coal-derived substances. Proceedings.* 437p. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The solubilization of low-ranked coals by fungi, such as Paecilomyces and Candida, in defined submerged culture systems has been demonstrated. Current efforts focus on the characterization of the aqueous solubilized coal products and the development of technologies for their subsequent utilization. Solubilized coal products have been fractionated and preliminary characterizations performed. Differences in product composition have been detected with respect to the organism used and culture duration. Prospects for the conversion of the aerobically solubilized coal into less-oxidized products have been considered. Anaerobic methanogenic consortia have been developed which can remain active and viable in the presence of the aqueous coal product or vanillin, a coal model compound. The results suggest that a methanogenic consortium was able to produce methane and carbon dioxide, using the product of coal biosolubilization by Paecilomyces as a sole carbon source. Work continues on the development of cultures able to convert the aqueous coal product and its various fractions into methane or fuel alcohols.

50325 (IEACR–29) **Natural oxidation of coal.** Davidson, R.M. IEA Coal Research, London (UK). ©Sep 1990. 76p. Sponsored by International Energy Agency. Source: IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom.

This review examines the effects of natural weathering and low temperature (<150°C) oxidation on the chemistry, structure, and properties of coal. The extent of oxidation of a coal sample is difficult to assess. The techniques used to test whether a coal is oxidised and the extent of any oxidation are discussed. Because coal is a heterogeneous material, factors other than the coal's organic matter and oxygen can affect the oxidation reaction. These parameters, including minerals, moisture, thermal chemistry, and particle size and surface area, are considered. This is followed by an examination of the structural changes oxidation causes in the organic matter. Then the way in which oxidation affects the value of coal is assessed. Oxidation generally has a deleterious effect on the way coal behaves in combustion, beneficiation, and processing (especially carbonisation). Among the conclusions, the importance of coal's mineralogy and physical structure are noted. Some suggestions for further research are made. 244 refs., 47 figs., 9 tabs.

50326 **Development of a method for characterizing changes in coal and mineral surfaces resulting from beneficiation processes.** Slomka, B.J. (Ames Lab., Iowa State Univ. (US)); Seward, K.J.; Dawson, M.R.; Buttermore, W.H. pp. 9-14 of Proceedings of the 7th international coal testing conference. Coal Testing Conference, Charleston, WV (USA) (1989). pp. 96 (CONF-890305–: 7. international coal testing conference, Charleston, WV (USA), 21-23 Mar 1989).

This paper discusses a method for characterizing changes in coal and mineral surfaces resulting from sonication and other cleaning processes. This method employs a unique flow-cell to permit the

dynamic measurement of dye adsorption on coal and mineral particle surfaces. The rates and extents of adsorption of ionic dyes on Illinois No. 6 coal were found to be dependent on mineral content and particle size of ground coal samples. A significant correlation was observed between the absorbed quantity of dye and the total mineral content of coal. In preliminary experiments with methylene blue dye, clay was found to adsorb significantly more of the dye than quartz, pyrite, calcite, or clean coal surfaces. By using dyes of differing adsorption selectivity, it is demonstrated that sonication reduces the apparent mineral content on the surface of coal.

50327 **Influence of weathering and low-temperature oxidation on the thermoplastic properties of coal.** Rashid, M. (USDOE Morgantown Energy Technology Center, WV (USA)); Jenkins, R.G. pp. 107-132 of Chemistry of coal weathering. Volume 14. Nelson, C.R. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). pp. 228

A review of the relevant literature demonstrates that the thermoplastic properties of coal are complicated functions of coal properties as well as the processing conditions at which coal is pyrolyzed. Swelling and softening properties of coal are influenced strongly by heating rate, coal particle size, and pressure. The influence of gas atmosphere (e.g., H_2) on coal swelling depends on the rate at which coal is heated or on the time spent by the coal at elevated temperature. Weathering or low-temperature oxidation of coal can significantly influence the thermoplastic properties of coal. Even a relatively insignificant amount of chemisorbed oxygen can markedly influence the swelling properties of coal. The extent of swelling for the preoxidized coal depends on pressure, gas atmosphere, and the amount of oxygen introduced during preoxidation. The thermoplastic properties of mildly oxidized coal can be restored by pyrolyzing the coal at elevated pressures of H_2.

50328 **Low-temperature (75 to 400°C) oxidation study of coal by diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy.** Smyrl, N.R. (Plant Lab., Oak Ridge Y-12 Plant, Martin Marietta Energy Systems, Inc., Oak Ridge, TN (US)); Fuller, E.L. pp. 587 of Proceedings of the 7th international conference on Fourier transform spectroscopy: Volume 1145. Cameron, D.G. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 642 DOE Contract AC05-84OR21400. (CONF-890674–: 7. international conference on Fourier transform spectroscopy, Fairfax, VA (USA), 19-23 Jun 1989).

In situ low-temperature air oxidation studies of subbituminous coal have been performed at 77, 125, 200, 300, and 400 °C by diffuse reflectance Fourier transform (DRIFT) spectroscopy. The oxidation reaction proceeds via oxygen insertion at aliphatic sites in the coal structure, which progressively produces aldo/keto groups, acid groups, and acid anhydride entities with the simultaneous consumption of hydrogen at these sites. The production of anhydrides occurs even at eh lowest temperature (77°C), but only about 200°C is there sufficient mobility of the acid functionalities for major quantities of the anhydride species to be formed. Above 400°C, the anhydro groups predominate in the steady-state production of carbon dioxide and water vapor. In addition to the detailed information concerning the carbonyl species, the spectra of the oxidized coal reveal some new information regarding the aromatic C-H stretching bands.

50329 **Discussion of recent conclusions concerning the structure of Victorian brown coal resinite: a reply to the comments of Wilson et al.** Anderson, K.B. (Argonne National Laboratory, Argonne, IL (USA). Chemistry Div.); Botto, R.E.; Dyrkacz, G.R.; Hayatsu, R.; Winans, R.E. *Fuel (UK)*, 69(7): 934-936 (Jul 1990). (CONF-8910463–: Coal structure 89 symposium, Jadwisin (Poland), 16-18 Oct 1989).

Short communication. BROWN COAL/molecular structure; MACERALS/molecular structure; MACERALS; MASS SPECTRA

0108 Waste Management

Refer also to citation(s) 50263, 50274, 50286, 50292, 50367, 50763, 50764, 50765, 50766, 50767, 50768, 50769, 50770, 50773, 51105

50330 (CONF-891185–1, pp. 16, Paper 15) **United States clean-coal technologies.** Womack, E.A. Jr. (Babcock and Wilcox Co., Alliance, OH (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference*. 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper provides an overview of clean-coal technologies and examples of state-of-the-art environmental control systems now in development. Technologies have been developed to reduce the quantities of sulfur oxides and nitric oxides released to the atmosphere. These technologies fall into four broad categories which include precombustion, advanced combustion, advanced postcombustion, and conversion. This paper briefly summarizes the current state-of-the-art technology which includes the use of physical cleaning, wet scrubbing, dry scrubbing, fluidized-bed combustion, and selective catalytic nitric oxide reduction. The paper goes on to discuss the developing technology in the areas of furnace sorbent injection, pressurized fluidized bed, and combined sulfur/nitric oxide removal techniques.

50331 (CONF-891185–1, pp. 31, Paper 19) **Role of clean coal technology in the energy future of the world.** Siegel, J.S. (Dept. of Energy, Washington, DC (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference*. 446p. Order Number DE90006339. Source: NTIS, PC A19.

This presentation consists of an outlined presentation by the U.S. Department of Energy's Deputy Assistant Secretary for Coal Technology. It outlines the U.S. DOE's clean coal technology program objectives to build and operate clean coal technologies at commercial scale by the mid-1990's and to obtain data needed for commercial decisions. The purpose of this clean coal technology is provide advanced coal-based systems for power generation and pollution control. The power generation aspects include improved burned economics, improved thermal efficiencies, modular construction, improved environmental performance, capability to repower existing facilities, and can use a variety of coals. The pollution control aspects deal with measures to control sulfur dioxides and nitric oxides. Outlines of various types of pollution control systems and retrofitting programs are provided. Additional information is provided on the U.S. coal reserve estimates and the projected cost of coal through the year 2000.

50332 (CONF-9009271–1-Vugraphs) **Identification of materials for hot-gas filter tubesheets.** Swindeman, R.W. (Swanson Engineering Associates Corp., McMurray, PA (USA)); Mallett, R.H. Oak Ridge National Lab., TN (USA); Swanson Engineering Associates Corp., McMurray, PA (USA). [1990]. 8p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From AR&TD direct utilization and instrumentation and diagnostics contractors' review meeting; Pittsburgh, PA (USA); 16-18 Sep 1990. Order Number DE91000645. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objectives of this work are to evaluate tubesheet designs and materials for the support of ceramic filters, assess alternative designs, collect information on commercial and advanced materials, and recommend a tubesheet material and design methodology for high-temperature service. Testing was performed on several alloys. Tests included tensile, creep, relaxation, strain cycling, and thermal cycling. Haynes Alloy 556 appeared to be promising. 7 refs., 9 figs.

50333 (DOE/MC/11076–2862) **Clean coal technology program/solid waste management.** Nordin, J.; Cameron, D.; Sheesley, D. Western Research Inst., Laramie, WY (USA). Mar 1989. 221p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90009684. Source: NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This report addresses solid waste management from generic clean coal technologies (CCT) processes, where 90% sulfur reduction is achieved. The technologies evaluated are: Atmospheric Fluidized-Bed Combustion (AFBC), Pressurized Fluidized-Bed Combustion (PFBC), Gasification, Advanced Slagging Combustion,

Boiler and Ductwork Sorbent Injection, Advanced Tailgas Cleanup, Physical Coal Preparation, and Chemical and Biological Coal Preparation. This report opens with a discussion of existing, proposed, and possible solid waste regulations as they apply to CCT. To help put CCT solid waste management in perspective, management of boiler ash and fly ash from conventional utility power plants is examined. Then the CCT processes are discussed. Each chapter is subdivided into the following subsections: Technology; Applications/Researchers; Quantities and Characteristics of Solid Wastes; Land Disposal and Leachates; Byproduct Use; Waste Minimization; Data Gaps and Research Needs. There is also a short section on NO_x removal followed by a general discussion on solid waste management. The report concludes with a list of general recommendations as related to solid waste management and CCT-3 solicitations. 18 tabs.

50334 (DOE/MC/22118–2905) **Field study of disposed solid wastes from advanced coal processes: Annual technical progress report, May 1989–May 1990.** Radian Corp., Austin, TX (USA). 1990. 5p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC22118. Order Number DE91000379. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Radian Corporation and the North Dakota Energy and Environmental Research Center (EERC) are funded to develop information to be used by private industry and government agencies for managing solid waste produced by advanced coal processes. This information will be developed by conducting several field studies on disposed wastes from these processes. Data will be collected to characterize these wastes and their interactions with the environments in which they are disposed. Three sites have been selected for the field studies: Colorado Ute's fluidized bed combustion (FBC) unit in Nucla, Colorado; Ohio Edison's limestone injection multistage burner (LIMB) retrofit in Lorain, Ohio; and Freeman United's site using waste from Midwest Grain's FBC unit in central Illinois. A fourth site is under consideration at the Dakota Gasification Company in North Dakota. The first two tasks of this project involved the development of test plans and obtaining site access.

50335 (STEV–1989-R25) **Handling of waste products from combustion.** Hartlen, J. (Statens Geotekniska Inst., Linkoeping (Sweden)). Statens Energiverk, Stockholm (Sweden). [1989]. 15p. (In Swedish). Order Number DE91707873. Source: NTIS (US Sales Only), PC A03/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

This report gives a general description of the management of combustion generated wastes and tries to elucidate the utilization of the wastes, their environmental effects and the economical aspects of their use. (U.W.).

0109 Environmental Aspects

Refer also to citation(s) 50263, 50334, 50351, 50373, 51661, 51688, 51872

50336 (CONF-891185–1, pp. 3, Paper 9) **Representative Ralph Regula.** East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper recognizes the United State's dependence on foreign energy imports and the importance of the U.S. coal reserve base to help lessen that imbalance. However, the implementation of clean-coal technology can have the opposite effect on this imbalance as to what the U.S. wants on energy source development. The paper states that the proposed acid rain bill would have a chilling effect on economic growth and jobs in the U.S. coal industry. However, a better alternative would be the Clean Coal Technology program. This program is currently using both Federal and private monies to develop better ways to reduce air pollutants associated with coal-fired facilities. The author emphasizes that the use of this approach requires time and that arbitrary clean air deadlines would result in abandoned research to utilize outdated technology for the purpose of regulatory compliance.

50337 (PB–90-259037/XAB) **Environmental monitoring plan for the Dow Syngas Project. Annual report, January 1-December 31, 1989.** Rozas, T.J. Louisiana Gasification Technology, Inc., Plaquemine, LA (USA). 31 Mar 1990. 136p. Source: NTIS, PC A07/MF A01.

See also PB–90-178328 and PB–90-259045.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic fuels plants. The Dow Syngas Project design is a high-temperature entrained-flow slagging type gasifier that began operating in 1987. Dow agreed to comply with existing environmental regulations and to develop an Environmental Monitoring Plan (EMP) incorporating supplemental monitoring areas of potential environmental and health concern, relative to synthetic fuels facilities. The phases of monitoring in the EMP will test parameters of interest in air, water and solid waste for evaluating plant operations and for establishing a data base of information for resolving environmental uncertainties relative to replication of synthetic fuels plants. Reports prepared under the EMP include Operating Phase Reports and Quarterly and Annual summaries.

0110 Reserves, Geology, and Exploration

Refer also to citation(s) 50326, 50353, 51884

50338 (CONF-891185–1, pp. 6, Paper 7) **Script of presentation by Senator Frank Murkowski on Alaska's coal potential.** East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper provides information on the largely untapped coal reserves of Alaska. Alaska contains a reserve base of almost 8 trillion tons of bituminous and subbituminous coal which offers affordable and accessible coal to the Pacific rim counties. While this vast coal reserve is currently available, it is only be slightly utilized. Access to year-round shipping facilities is not considered any problem since a deep-water, ice-free port is available. Leases and environmental regulations have also been satisfied for the development of many of these reserve areas. The paper goes on to emphasize the high quality of these Alaskan coals which contain less than 0.5% sulfur. It also summarizes the current uses of these coals in the state of Alaska and technology research being conducted on these low sulfur coals. Economic benefits are also discussed which compare shipping distances from Alaska as compared to other major coal-exporting countries.

50339 (CONF-891185–1, pp. 12, Paper 10) **The future of coal for power generation in Indonesia.** Andoyo, A. (Ministry of Mines and Energy, Jakarta Selatan (Indonesia)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper summarizes the development of electrical power supplies in Indonesia over a twenty-year period from 1968-1988 along with a look at the future of this development. It is expected that as a result of the increased demand for electricity from both the residential and industrial sector of the country that this development will continue to grow at accelerated rates until the year 2000. Coal will contribute larger shares of the electric power generation as the government will try to develop non-oil resources to save oil for export. A brief summary of the Indonesia coal reserves is presented along with numerous tables showing the generating capacity and power demand for this area of the Pacific Rim.

0120 Mining

Refer also to citation(s) 50262, 51884

50340 (EUR–12312-EN) **Development of a pickforce steering system.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1989. 2 vols., 423p. Source: Commission of the European Communities, Luxembourg.

The surface trial of the pickforce principle as applied to ranging drum shearers took place as Swadlincote Test Site in 1984 and 1985 using a simulated coalface. The pickforce signal was transmitted via a FM/FM telemetry system, powered from a drum-mounted power supply, to the pickforce executive. Pick position was detected using a system of magnetic proximity probes. The steering control was machine-mounted using the pickforce executive module, developed at HQTD, from the System 70,000 machine executive. Although the amount of cutting which could be carried out was limited, the system successfully steered to a desired horizon +−13 mm. The performance of both system hardware and software was encouraging. The underground trial took place at Cotgrove Colliery, Nottinghamshire Area, in 1985 and 1986. Unfortunately, the pickforce steering system remained unproved due mainly to poor geological conditions and the effect of these conditions on the level of reliability of certain parts of the system. However limited, pickforces were obtained and subsequently analysed. The results from the surface trial indicated that if a reliable force pattern, by virtue of stratification, was present within a given seam and if this force pattern could be reliably and consistently measured, pickforces could be used as a streering datum. Results obtained from the underground trial were inconclusive in that they were obtained without a leading pick to ensure a constant depth of cut on the force measuring pick. Therefore, further trials or monitoring of pickforces, subject to certain parts of the system being re-engineered, are recommended. 3 refs., 39 figs.

50341 (EUR–12324-DE) **Development of a method of mine gas control.** Muecke, G.; Paul, K. Bergbau-Forschung GmbH - Forschungsinstitut des Steinkohlenbergbauvereins, Essen (Germany, F.R.). 1990. 148p. (In German). Source: Commission of the European Communities, Luxembourg.

Describes the measurement of gas flow in coal seams of the Nordstern, Ibbenbueren, Rheinpreussen and Haus Aden collieries, and laboratory tests designed to investigate the relationship between pressure mechanisms and dynamic gas emission processes in coal. Presents the results of mine monitoring in the Radbod and Rheinpreussen collieries and discusses ways of improving gas outburst preventative measures.

50342 (EUR–12325-EN) **Feasibility of controlled ventilation.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1990. 65p. Source: Commission of the European Communities, Luxembourg.

British Coal ventilation power costs for the year ended 1986/87 were 62.3 million. By exploiting currently available ventilation planning tools more cost effective ventilation systems can be designed and substantial savings in power costs achieved. The principle of selecting a main fan to run at a minimum duty in conjunction with a suitably sited underground booster fan can lead to a substantial lowering of power costs, compared with conventional whole mine ventilation from a surface fan. Air supply and demand could be more closely matched if more use was made of variable-speed fans, especially during non-production periods when considerable power savings would accrue. The accuracy of a ventilation network, derived from a pressure/quantity survey, is likely to be of the order ±15% and this uncertainty should be borne in mind when planning changes. The opportunities for closely controlling ventilation are likely to decrease as greater continuity of production is being sought, e.g. six day working. Limited automation of fan control has been successful, but it is considered that expenditure of the technological developments required to approach total automatic control of mine ventilation cannot be justified either in terms of increased safety or reduced costs. However, computer assistance with information management and decision making, in connection with mine environmental control, could offer benefits leading to a reduction in downtime and hence a reduction in production costs.

50343 (EUR–12502-EN) **Further work on design and stability of roadway support systems.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1990. 309p. Source: Commission of the European Communities, Luxembourgh.

This report details the findings of several investigations into different aspects of coal mining rock mechanics in the U.K., namely gate roadway stability combined with thick seam mining and main access tunnel stability using both heavy duty steel and concrete support systems. The role of empirical and numerical design methods is also examined and utilised in connection with the rock mechanics investigations, thus attempting to bring predicted and measured behaviour closer together. A series of mechanical tests on T-H support yielding mechanisms has also been performed and the results are reported in connection with gate roadway stability behaviour. The results of this contract have highlighted areas of rock mechanics which are not fully understood and need extensive further investigation as a result. Similarly, the comprehension of tunnel behaviour in soft rocks has been furthered which ultimately will lead to improve practices being employed in the design and implementation of underground openings.

50344 (EUR–12511-EN) **Automatic control of drilling jumbos.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1990. 102p. Source: Commission of the European Communities, Luxembourg.

The report summarises the concept, preliminary surfaces appraisals and final underground trials of the Perard Torque Tension prototype twin boom computer controlled drilling machine for use in coal mines. The form of the machine assessment was initially through simple operational and drilling exercises carried out in a limestone mine. The main function of these preliminary trials was for design problem identification, operational suitability/integrity and reliability appraisal of both machine hardware and systems. Subsequent underground trials were carried out, once the machine had achieved acceptable reliability and performance, so that the potential benefits, associated with a full drilling and firing cycle, could be analysed.

50345 (EUR–12516-DE) **Advances in electrical network technology II.** Schenke, G.; Schuetz, R. Bergbau-Forschung GmbH - Forschungsinstitut des Steinkohlenbergbauvereins, Essen (Germany, F.R.). 1990. 107p. (In German). Source: Commission of the European Communities, Luxembourg.

A flameproof, thyristor-controlled 10x100 kvar instantaneous reactive current compensation unit, developed during a previous project, was incorporated into a 500V underground mains system. The unit has various functions: discharging reactive current from the underground power supply network; reducing voltage drops as well as losses in cables and conductors; enhancing the capacity factor and torque of asynchronous motors in the starting phase. Flameproof, pole-reversible asynchronous motors are powered via 2 power lines. If they are operated in 2 directions (as is the case for a coal plough), 4 vacuum contactors are required, together with protective and monitoring devices. A twin-type reversing switch with magnetic drive for a 1000V, 315A current was developed, along with a control which when used in conjunction with the usual protective and monitoring devices, one vacuum contactor and the twin-type reversing switch, can be used to switch a pole-reversible asynchronous motor. The installation was tested with a 10/42 kW asynchronous motor and the time requirement for one reswitching sequence found to be ~250ms. Flameproof switches using sulphur hexafluoride as the erasing gas and with metal enclosures were developed for installation in gateroads. 35 refs., 39 figs., 8 tabs.

50346 (EUR–12519-FR) **New drilling techniques.** Centre d'Etudes et Recherches des Charbonnages de France (CERCHAR), 92 - Rueil-Malmaison (France). 1989. 59p. (In French). Source: Commission of the European Communities, Luxembourg.

This report describes research into drilling problems encountered in two French coalfields, and the solutions devised. Eleven km of gateroad per year are bolted in the Houilleres de Provence. Here, a lightweight roofbolting machine was studied and tested, but its use was hampered by an unexpected dip in the seam. At the same time, modifications to manual rotary drilling equipment succeeded in making some tasks less arduous and improving performance by 35% in drilling for roof bolts. In addition, improvements were made

to an existing roof bolting rig which was used in support operations for advance headings. This made it possible for a single machine operator to set 12 bolts per hour. In the Houilleres de Lorraine, research focussed on two main areas. 1. In a stone drift with full roof bolting, the first Montabert twin-arm, electro-hydraulic drilling jumbo was put into service. A study of of its performance compared to conventional electro-pneumatic jumbos showed a 40% reduction in the time required for roof bolt setting. In addition, special drill rods and roof bolts were tested on these two machines. 2. At the working face and particularly in steep seams, the special rotary drilling equipment with hand drill was the subject of a series of tests both in the laboratory and in the work place. These resulted in the elimination of a number of drill rods and bits used in roof bolting and in the standardisation of the most successful equipment.

50347 (EUR–12545-DE) **Computer-assisted district control centres.** Bergbau-Forschung GmbH - Forschungsinstitut des Steinkohlenbergbauvereins, Essen (Germany, F.R.). 1990. 26p. (In German). Source: Commission of the European Communities, Luxembourg.

The work carried out within the framework of the project covered software development for sub-centers. Two basically different programming methods were used. Analogously to the district control centers developed in Part A and Part B of this project, sub-systems for monitoring supply and disposal networks were developed or adapted using conventional programming techniques. As for the surfac -installed district control centers, the on-site installed autonomous control systems for mine services networks can be monitored by a computer-based sub-center on the surface. In addition, the process computer can also carry out direct control and optimization tasks if the necessary data and reports of the network to be controlled are logged in the sub-center. In parallel, preliminary investigations on the possible use of 'artificial intelligence' in district control centers were run with respect to intelligent software and to expert systems. A suited development system once determined, an expert system for practice of the escape way directives was completed as a first step towards the methodology of knowledge processing. This pilot project is to be regarded as preliminary work on developments to be carried on with in further research and development projects started meanwhile.

50348 (EUR–12656-EN) **Development of underground switchgear.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1990. 255p. Source: Commission of the European Communities, Luxembourg.

Electrical distribution networks at collieries must cope with diverse mine layouts, the increasing power requirements of mining machinery, and a growing trend towards the use of higher voltages in hazardous areas near to the coal face. As the management and control of such networks becomes increasingly complex, management systems need to provide accurate, meaningful information which can help in detecting potential hazards and lead to safer, more reliable and more cost effective operation. The report describes the trials of a MINOS computer-based Switchgear Monitoring and Control system and gives a detailed account of the development of an intelligent microprocessor-based unit for use inside switchgear. The system provides the distribution network status, engineering information, warning and alarm messages, and remote operation, all of which allow confirmative and/or corrective action to be taken to minimise danger and reduce production delays. The system also stores data so that past events and discrepancies can be analysed, thereby increasing management understanding of distribution networks.

50349 (EUR–12658-EN) **Underground data communications.** British Coal Corp., Stanhope Bretby (UK). Headquarters Technical Dept. 1990. 337p. Source: Commission of the European Communities, Luxembourg.

The aim of this project was to design and laboratory test a date transmission system for mines, followed by a field trial to test the transmission of data to the surface under practical mine conditions. The data transmission system was based on a multi-drop network of 64 kilobit per second intrinsically safe modems (not part of this project) operating over conventional pit telephone-type cables. Underground, these formed part of a modular data concentrator and display station (Waystation), and at the surface interfaced to a monitoring and control system (MINOS). The Waystations communicated with flameproof switchgear, part of ECSC Project 7220-AF/814 - Development of underground switchgear, via BS6556 circuits to provide a realistic source of traffic. CONIC, a distributed monitoring and control language developed by Imperial College London for British coal, was adopted for the project. The project was divided into four phases. Phase 1, system design, aimed to work out the basic parameters of the proposed system and set up the mechanisms to achieve the desired objectives. Phase 2, laboratory system, was aimed at providing the necessary facilities to carry out the development on the surface pending the availability of intrinsically safe components. Phase 3, a passive underground trial, was designed to test the data transmission system itself without carrying any live traffic. Finally, Phase 4, the active underground trial, would extend the system to add monitoring and control of underground plant to fully test the system under practical conditions.

50350 (EUR–12662-ES) **Automated inspection of contact wire by artificial vision.** Catalina, J.C. AITEMIN, Madrid (Spain). 1990. 87p. (In Spanish). Source: Commission of the European Communities, Luxembourg.

The objective of this project is to develop an automated system for measuring contact wire wear in mining railway systems using electric traction. This system would employ optical devices and use artificial vision techniques, testing and feasibility of this inspection system. A prototype sensor has been designed, based on illumination with structured light (laser) and a matrix CCD camera feeding data to a computer-controlled image processing system. The whole system is mounted on a specially adapted wagon towed along the stretches of track inspected. The system provides readings of wire wear and of its position with regard to the track. This sensor is mounted on a mobile structure with two degrees of freedom to enable the sensor to track vertical and horizontal wire displacements. Given the type of installations where this system has to operate and as this is a prototype, it has been built without protection against explosive atmospheres. Tests performed in situ in the mine and in the laboratory have demonstrated system feasibility and effectiveness, while also detecting certain limitations and possible improvements for future development work. The possibility of using the system for conventional above-ground railways lines has also been investigated.

50351 (NZERDC-P–123) **An engineering geological investigation of ground subsidence above the Huntly East Mine.** Kelsey, P.I. New Zealand Energy Research and Development Committee, Auckland (New Zealand). Oct 1987. 129p. Source: Ministry of Commerce, Energy and Resources Division, P.O. Box 2337, Wellington (New Zealand).

Ground subsidence above the Huntly East Mine at the N.Z.E.D. Hostel has affected an area of approximately seven hectares with measured settlements of over 800mm. Extensive damage was suffered by most buildings and services of the hostel complex To determine the cause(s) and mechanism(s) of the subsidence, site and laboratory investigations were undertaken. Site investigations included core and wash drilling, geophysical borehole logging, dutch cone penetrometer soundings plus piezometer installation and monitoring. Laboratory investigations included one dimensional consolidation and permeability testing, SEM fabric studies, XRD and chemical tests for clay mineralogy, and determinations of Atterberg Limits and grain size distributions. The mine overburden geology at the site consists of a 35 to 60m thick sequence of mudstones and coal seams of the Te Kuiti Group (Eocene to Oligocene), and overlain by a 50 to 70m thick succession of saturated sands, silts and gravels of the Tauranga Group (Pliocene to Holocene). Within the Tauranga Group three aquifers are present. The engineering geological model considered most likely to explain the subsidence is mine roof collapse causing void migration to near the top of the Te Kuiti Group sequence resulting in drainage and depressurising of aquifers at the base of the Tauranga Group. Aquifer depressurisation is considered likely to cause consolidation within both the aquifer and aquitards associated with it. Back-analyses of the dewatering consolidation model in terms of both magnitude and rates of settlement are consistent with observed values. A finite difference numerical analysis was developed for estimations of settlement rates. 98 refs., 67 figs., 12 tabs.

50352 (UKY-BU-151) **Proceedings, 1989 multinational conference on mine planning and design.** Lineberry, G.T.; Unrug, K.F. (eds.). Kentucky Univ., Lexington, KY (USA). Office of Engineering Services. May 1989. 248p. (CONF-8905300--: 1989 multinational conference on mine planning and design, Lexington, KY (USA), 23-26 May 1989). Source: OES Publications, 226 Anderson Hall, University of Kentucky, Lexington, KY 40506-0046, USA.

34 papers are presented covering the safe and economical planning and design of future underground and surface mines. The papers are arranged under the following session headings: geologic factors and rock mechanics considerations; mine design methodology; operational considerations; underground mine planning and design; surface mine planning and design; innovative design and economic evaluation of design.

50353 Cross-borehole observation of mode conversion from borehole Stoneley waves to channel waves at a coal layer. Albright, J.N. (Los Alamos National Lab., NM (USA)); Johnson, P.A. *Geophysical Prospecting (USA)*, 38(6): 607-620 (Aug 1990).

Conversion of borehole Stoneley waves to channel waves was observed in data from a seismic cross-borehole experiment conducted between wellbores penetrating a thin coal layer at 2022 m depth, near Rifle, Colorado. Traveltime moveout observations show that borehole Stoneley waves underwent partial conversion to channel waves at the coal layer. The channel waves were detected directly in an adjacent borehole 35 m away at receiver positions within the coal. Stoneley waves, subsequently produced by partial conversion of channel waves, were also detected at receiver positions located up to 50 m above and below the coal layer in the adjacent borehole. The authors infer the channel wave to be the first-higher Rayleigh mode by comparing the observed group velocity with theoretically derived dispersion curves.

0130 Transport, Handling, and Storage

50354 (AD-A-223746/9/XAB) **Suppression methods for deep-seated coal fires. Final report.** Schultz, H.E.; Richards, R.C. Coast Guard, Groton, CT (USA). Marine Fire and Safety Research Div. Mar 1990. 122p. (CG-MFSRD-49). Source: NTIS, PC A06/MF A01.

This study was a joint U.S. Coast Guard/Maritime Administration effort to identify fire prevention and/or suppression techniques for spontaneously induced coal cargo fires. The four test series conducted investigated spontaneous ignition, permeation, fire quench, and coal column fire characteristics. The spontaneous ignition tests identified variables that could be controlled in an attempt to prevent combustion. Results showed spontaneous ignition difficult to predict and, therefore, control. The permeation studies evaluated carbon dioxide and nitrogen as suppression agents. Results indicated the retention time of nitrogen in a coal pile to be far greater than the retention time of carbon dioxide. The fire quench tests compared these agents applied to a hot fire. Results showed both equally effective at displacing oxygen. The coal column tests applied these agents to a deep-seated fire at different locations. Results supported those of the permeation studies and showed mid-level injection of the agents to be most effective. Thus, the study indicates a portable system that applies nitrogen to the middle of the coal pile to be most effective. Large-scale work should be done to verify this.

50355 (CONF-891185-1, pp. 51, Paper 16) **Pacific rim coal trade issues innovative transport modes.** Brolick, H.J. (Williams Technologies, Inc., Tulsa, OK (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference*. 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper discusses the feasibility of slurry pipelines to transport western U.S. coal to the deep-water ports along the Pacific Ocean. This procedure could open up the U.S. export market for coal, making it more competitive with other coal exporting countries. The paper discusses the efficiency of these pipelines which are in use on a small scale at several mine/power plant situations around the country. The cost of transporting coal by this method as compared to conventional transportation systems is also shown to be highly economical. Brief discussion is given to dual commodity pipelines, such as coal and liquid carbon dioxide or coal and methanol, which could lower the cost of both commodities.

50356 (CONF-891185-1, pp. 29, Paper 17) **Innovative/alternative ocean transport modes for movement of U.S. coal exports to the Asian Pacific basin.** Uttmark, G.F. (TransTech Marine Co., Brooklyn, NY (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference*. 446p. Order Number DE90006339. Source: NTIS, PC A19.

The primary attempt of this paper was to examine U.S. port facilities and cost for handling coal and to determine baseline costs of ocean transport of U.S. coals to Asia. The paper discusses the existing coal loading facilities located on the west coast and there specifications for size of vessel and loading rate. Based on these findings, methods to improve and lower the ocean transport coast of coal exports from the U.S. includes upgrading for larger ships, supplemental cargos to lower cost for both commodities, and use of coal water fuel tankers. Unless the U.S. continues to explore and commit resources to improving efficiency and competitiveness, the role of U.S. coal exports will continue to drop.

50357 (CONF-891185-1, pp. 14, Paper 23) **Innovative/alternative transport modes for movement of U.S. coal exports to the Asian Pacific basin.** East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference*. 446p. Order Number DE90006339. Source: NTIS, PC A19.

While the United States may contain the largest coal reserve of any country in the world, it has achieved less than a 10% share of the rapidly growing steam-coal market in the Asian Pacific Basin. High inland transportation costs, combined with relatively low calorific value of some western coals, have resulted in prices exceeding world market levels in recent years. The purpose of this study is to identify and describe transport innovations and alternatives which may reduce the delivered cost of U.S. steam coals in this market. Alternatives investigated include innovative approaches to rail and ocean transportation, coal-slurry pipeline transportation, and coal blending possibilities, as well and unconventional transport modes such as long overland conveyors and intermodal moves in containers. The study includes a comparison of possible delivered prices for the coals of interest, based on a variety of transportation-combination scenarios.

50358 (DOE/PC/88947-T7) **Development and utilization of new diagnostics for dense-phase pneumatic transport: Quarterly technical progress report, April 1, 1990-June 30, 1990.** Cornell Univ., Ithaca, NY (USA). [1990]. 20p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88947. Order Number DE90017885. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Dense-phase pneumatic transport is an attractive means of conveying solids. Unfortunately, because of the high solid concentrations, this transport method is a difficult regime in which to carry out detailed measurements. Hence most details of the flow are unknown. In this contest, the main objective of this work is to develop probes for local measurements of solid velocity and holdup in dense gas-solid flows. In particular, capacitance probes are designed to measure local, time-dependent particle concentrations. In addition, a new optical fiber probe based on laser-induced-phosphorescence is developed to measure particle velocities. In this reporting period, we have simulated the performance of the optical-fiber anemometer probe using a three-dimensional ray-tracing Monte-Carlo technique. In particular, we have calculated the radiant energy field emerging from the GRIN lens, and we have determined the measurement volume of the probe. 1 ref., 5 figs.

0140 Combustion

Refer also to citation(s) 50313, 50334, 50501, 51105, 51106

50359 (ANL–90/17) **A comparative study of iron-, nickel-, and cobalt-base weldments exposed in TVA 20-MW and Rocketdyne atmospheric fluidized bed combustors.** Wang, D.Y.; Natesan, K. Argonne National Lab., IL (USA). Jun 1990. 36p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90018012. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Experimental iron-, nickel-, and cobalt-base weldment materials were exposed in TVA 20-MW and Rocketdyne atmospheric fluidized bed combustors (AFBCs) at 849°C for 1261 h and 871°C for 1000 h, respectively. Postexposure analyses were conducted at Argonne National Laboratory. All specimens experienced different degrees of internal oxidation/sulfidation. Among eight filler materials, Marathon 25/35R and Haynes 188 showed the least corrosion attack, i.e., less than 0.5 mm/yr. A high nickel content in the weldment was unfavorable for corrosion resistance in the AFBC environment. Differences in the coal/bed chemistry of the TVA and Rocketdyne systems yielded different corrosion behavior in the materials. Calcium sulfate deposits on the specimens significantly affected the internal oxidation/sulfidation of the alloys. The results of this study supplement the material data base, in particular that of weldment performance, and aid in materials selection for AFBC applications. 10 refs., 22 figs., 4 tabs.

50360 (ANL/EAIS/TM–23) **An analysis of markets for small-scale, advanced coal-combustion technology in Spain, Italy, and Turkey.** Placet, M.; Gerry, P.A.; Kenski, D.M.; Kern, D.M.; Nehring, J.L.; Szpunar, C.B. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Sep 1989. 100p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE91000082. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report discusses the examination of potential overseas markets for using small-scale, US-developed, advanced coal-combustion technologies (ACTs). In previous work, member countries of the Organization for Economic Cooperation and Development (OECD) were rated on their potential for using ACTs through a comprehensive screening methodology. The three most promising OECD markets were found to be Spain, Italy, and Turkey. This report provides in-depth analyses of these three selected countries. First, it addresses changes in the European Community with particular reference to the 1992 restructuring and its potential effect on the energy situation in Europe, specifically in the three subject countries. It presents individual country studies that examine demographics, economics, building infrastructures, and energy-related factors. Potential niches for ACTs are explored for each country through regional analyses. Marketing channels, strategies, and the trading environments in each country are also discussed. The information gathered indicates that Turkey is a most promising market, Spain is a fairly promising market, and Italy appears to be a somewhat limited market for US ACTs. 76 refs., 16 figs., 14 tabs.

50361 (CANMET–80-75(TR)) **The Summerside Project: An AFBC [atmospheric fluidization-bed combustion] boiler for high-sulphur coal and wood chips.** Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Oct 1980. 36p. (MICROLOG–90-04508). Source: PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20-C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The paper describes two conceptual designs of a coal-burning atmospheric fluidized-bed combustion (AFBC) demonstration heating plant planned for Atlantic Canada. The designs were prepared under contract by two separate teams of designers of which one drew upon British, the other upon American technology. The demonstration plant will consist of two boilers each generating 18 Mg/h of medium-pressure steam. The design fuel is high-volatile bituminous coal containing approximately 20% ash and 5% sulphur. Wood chips have been specified as a supplementary fuel to provide up to 30% of the heat input. Additional design criteria call for overbed feeding of 50 mm by 0 coal, special provisions to deal with wet and frozen coal, 4.5 to 1 turndown range, and emisssion limits on SO_2, NO_x and particulates. The two conceptual boiler designs differ substantially. One proposes four identical bed sections with forced circulation bed cooling and overbed feed of coal, limestone and wood chips by means of water-cooled screw conveyors. The other design proposes spreader-firing of the fuel onto two bed sections, one being a preferential bed having only peripheral cooling, the other being a secondary bed with in-bed as well as peripheral cooling. This design uses natural circulation throughout. Some data from pilot-scale tests with the design coal and limestone are also presented. 5 figs., 10 tabs.

50362 (DOE/MC/24207–2849) **Erosion of heat exchanger tubes in fluidized beds: Annual report.** West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering. Apr 1990. 51p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-87MC24207. Order Number DE90009660. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The initial objective of this project was to develop a scaling procedure to predict in-bed heat transfer tube erosion rates in fluidized-bed combustors (FBC). Specifically, the localized tube erosion rates were to be related to the circulation patterns of the bed material. This objective was to be accomplished by comparing the results of the Morgantown Energy Technology Center's (MET) 6×6 bed with those obtained from a geometrically similar 2×2 bed constructed and operated at the West Virginia University (WVU). However, instead of emphasizing scaling as an approach to erosion rate analysis, the development of a model for erosion rates was recommended. This model would be based on data from the WVU 2×2 bed, the METC 6×6 bed, and from a new 6×6 bed at WVU. It is intended that the model will involve bubble dynamics; subsequently, the scaling problem will be one of scaling the bubble dynamics of an FBC unit. At least four tube materials will be tested: two high temperature steels now employed in FBC's, aluminum, and graphite. For the bed material, crushed quartz is the reference material and several mixtures of coal ash (mineral matter) and calcium compounds will be employed to represent typical FBC bed material. Accomplishments for 1989 were: (1) Completed a set of runs to evaluate tube materials for maximum erosion rates and to satisfy one condition of the initial test matrix. (2) Analyzed the recent erosion and scaling literature in order to evaluate our results and to understand the erosion and scaling processes. (3) Re-evaluated the initial technical approach to this project based on our results and the recent literature. 27 refs., 20 figs., 7 tabs.

50363 (DOE/MC/24207–2852) **Theoretical and numerical studies of constitutive relations for frictional granular flow: Annual report, January–December 1989.** Gray, D.D.; Stiles, J.M. West Virginia Univ., Morgantown, WV (USA). Dept. of Civil Engineering. Apr 1990. 37p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-87MC24207. Order Number DE90009662. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes progress made during the period January 1 through December 31, 1989. Most of the effort in the first three quarters of this period was devoted to assigning numerical values to material constants used in the frictional granular constitutive relationship and implementing that constitutive relationship in the computer program MFIX. MFIX is a hydrodynamic code that models the fluidized flow of solid particles of various sizes and densities. However, because of the apparent lack of success in implementing the frictional constitutive relationship in the computer program MFIX, it was decided that future work should be directed toward writing problem-specific computer programs for several test problems. The computer program CHUTE is a three-dimensional semi-implicit finite difference hydrodynamic code designed to solve the truncated momentum equation along with the other governing equations for the frictional gravity flow of granular materials down an inclined open channel. The initial results generated by program CHUTE have indicated that fatal errors are present in the subroutine that adjusts the velocities. Work to rectify these errors is in progress. 9 refs.

50364 (DOE/PC/88929–T6) **Scale-up of circulating fluidized bed coal combustors: Eighth quarter technical progress report, June 1, 1990–August 31, 1990.** Louge, M.Y. Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering. [1990]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88929. Order Number DE91000850. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This experimental project has been aimed at quantifying the effects of scale-up upon the hydrodynamics of Circulating Fluidized Bed (CFB) coal combustors. We have have constructed a cold CFB facility with the ability to recirculate-rather than discard-fluidization gas mixtures of adjustable density and viscosity. Hydrodynamic analogy between the cold bed and a coal combustor is achieved by matching all relevant dimensionless parameters. Several choices of gas composition and particle properties make the cold flow analogous to that in combustors of diameters in the range 0.3 to 1m. Therefore, for the first time, scale-up effects are quantified directly using a single cold flow facility. During the previous reporting period, we carried out the first two phases of the scale -up experiments i.e., the fluidization of glass beads and plastic pellets using mixtures of helium and carbon dioxide. This quarter, we have completed the third phase of the scale-up experiments using iron flakes. By fluidizing two glass powders of identical characteristics but largely different surface friction coefficients, we have discovered that particle friction affects the flow. Effort has also been on modeling particle interaction in gas-solid flows using elements of rapid granular flow. Because detailed measurements of velocity fluctuations are not yet available in dense flows, we have first considered dilute, turbulent flows of relatively massive particles. Finally, we have/studied the heat transfer from a suspension of massive particles of low Biot number transported in a vertical pipe. 9 refs., 2 figs., 1 tab.

50365 (DOE/PC/88937–T5) **Experimental studies on group ignition of a cloud of coal particles: Quarterly progress report No. 5, August 16, 1989–November 15, 1989.** Annamalai, K. Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering. [1989]. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88937. Order Number DE90017883. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Objectives for this quarter were to: Conduct further stream experiments on coal particles to investigate the ignition time at different temperatures; conduct experiments on char particles; conduct stream experiments using coal particles to investigate the ignition temperature variation with mass flow rate; and interpret the ignition data. Activities included: Stream experiments using coal particles; the effect of gas temperatures on ignition time were investigated; and the char experiments were postponed to summer 1990. Ignition temperature data were obtained. Ignition time data were interpreted using the model results. 15 figs.

50366 (DOE/PC/90753–T14) **Coal ash deposition and interaction with metal substrates: Final report.** Birks, N. Pittsburgh Univ., PA (USA). Dept. of Materials Science and Engineering. [1987]. 105p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90753. Order Number DE90016755. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report discusses mechanisms by which coal ash deposits attack superheater and reheater alloys (stainless steel-304). The attack on oxide scales by molten sulfates is described. 80 refs., 63 refs., 8 tabs. (CBS)

50367 (IS-T–1460) **An investigation of the mechanisms of calcination and sulfation in coal-water mixtures.** Christofides, N. Ames Lab., IA (USA). 21 Sep 1990. 59p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-82. Order Number DE91000663. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The purpose of this investigation is to study the mechanisms of sulfur capture when burning coal-water-limestone mixtures (CWLM) in fluidized beds. Special care is taken to make comparisons with to dry coal and sorbent under comparable experimental conditions. A series of experiments were performed in an eight-inch diameter bubbling fluidized bed combustor to address this problem. 33 refs., 17 figs., 5 tabs.

50368 (PB–90-255688/XAB) **Costs for advanced coal-combustion technologies. Final report.** Martinez, J.A.; Snow, G.C.; Maibodi, M. Radian Corp., Research Triangle Park, NC (USA). Aug 1990. 105p. Contract EPA-68-02-4286. Source: NTIS, PC A06/MF A01.

The report gives results of an evaluation of the development status of advanced coal combustion technologies and discusses the preparation of performance and economic models for their application to electric utility plants. The technologies addressed were atmospheric fluidized bed combustion (AFBC), pressurized fluidized bed combustion (PFBC), and integrated gasification combined cycle (IGCC). The development status was also reviewed for pulverized-coal-fired (PC) boilers incorporating supercritical steam cycles. Although advanced combustion technologies are attractive due to decreased SO2 and NOx emission characteristics and potentially higher generating efficiencies, full commercial readiness does not appear feasible before the mid to late 1990s. Capital cost estimates for a new plant at 500 MW ranged from $1,250 to $1,910/kW for advanced technologies and from $1,380 to $1,810/kW for conventional systems. Capital cost estimates for PFBC (turbocharged cycle) and conventional plants with add-on SO2 and NOx controls were within 4% of the median cost ($1,580/kW) of all technologies evaluated. AFBC costs averaged 12% less than this median, while IGCC costs averaged 11% above the median. Potential capital cost savings for repowering an existing plant versus constructing a new facility at the same final capacity are between 10 and 40%.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50262, 50331, 50336, 50338, 50339, 50356, 50357, 50360

50369 (CONF-891185–1, pp. 7, Paper 1) **U.S. and the Pacific Rim: Fueling tomorrow's progress.** Swink, D. (Dept. of Energy, Washington, DC (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper summaries the U.S. Department of Energy's stance on coal resource development and transportation among the Pacific Rim countries of the world. The paper emphasizes the importance of coal in the developing and industrialized countries of the Pacific Rim because of the shortage potential and unpredictability in supply in petroleum-based energy sources. A move away from oil could raise coal-fired electricity from the 12,000 megawatt capacity to as much as 50,000 megawatts by the year 2000. The paper goes on to discuss the role U.S. coal can play in this supply scenario, including the use of coal from the Rocky Mountain states using both conventional and slurry modes of transportation.

50370 (CONF-891185–1, pp. 28, Paper 3) **Future coal-fired generation plan of Taiwan Power Company.** Chang, Simin (Taiwan Power Co., Taipei (Taiwan)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper discusses the current capacity and demand for electric power in Taiwan. The utility is called Taiwan Power Company and is a state-owned operation. The goal of the paper is to present an overall picture of the current status and long range power development program proposed by the utility. Emphasis is on coal-fired steam plants. It discusses the coal procurement policy which includes coal sources, acquisition approaches, quality control of coal, and purchasing procedures.

50371 (CONF-891185–1, pp. 20, Paper 4) **Future coal-fired generation and capacity requirements of the Philippines.** Aboitiz, E.M. (Philippine National Power Corp., Quezon (Philippines)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington,

DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

The Philippine power industry had been heavily dependent on oil-based generation in the Seventies and, as a result, was adversely affected by the rapid oil price fluctuations of the period. Because of this, the government has taken action to encourage the exploration and development of indigenous energy resources. The country has a numerous undeveloped energy resources which include hydroelectric, geothermal, and coal. This paper focuses in on the coal industry in the Philippines and discusses coal ownership and control, environmental consequences, coal quality, and the capacity and current generation of the existing coal-fired steam plants.

50372 (CONF-891185–1, pp. 15, Paper 5) **Steam coal demand for power generation in Korea.** Jeong, Kun (Korea Electric Power Corp., Seoul (Korea)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper briefly discusses the steam coal demand and the available coal resources of Korea. It goes on to discuss the prospects of electricity demand, a summary of power development projects, the outlook for steam coal demand, and the environmental constraints associated with coal-fired power plants. Figures on electricity sales and peak loads are also provided along with the capacity of the existing units.

50373 (CONF-891185–1, pp. 8, Paper 8) **Senator Mitch McConnell remarks before the Asia-Pacific Coal Technology Conference.** East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper discusses the United States commitment to both the development of coal resources and clean-coal technology. It provides a summary of the various U.S. technologies being applied to help reduce the potential for acid rainfall along with the research being developed through both the U.S. Department of Energy and the nation's coal producers. The paper goes on to express the significance of coal in the worlds energy picture and forecasts the energy demand for the developing Pacific rim countries.

50374 (CONF-891185–1, pp. 24, Paper 11) **Electric power system in Thailand.** Suthiphongchai, C. (Electricity Generating Authority of Thailand, Nonthaburi (Thailand)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper presents the energy policy for the Electric Generating Authority of Thailand, which is the utility responsible for the generation and transmission of electric power throughout the country. It presents a brief description of Thailands geography and the historical development of energy resources in this country. It goes on to provide the generating capacity of the various fossil-fueled power plants along with providing the power development plan for the country. This policy is a five-fuel policy which includes the use of hydroelectric, natural gas, crude oil, lignite, and import coal. The lignite reserve is the most abundant resource of Thailand and proposals for minemouth power plants is described. The potential for power exchange with neighboring countries is also discussed.

50375 (CONF-891185–1, pp. 18, Paper 12) **Coal in Malaysia - A position paper.** Rahman, A.A. (National Electricity Board, Kuala Lumpur (Malaysia)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper provides a history of energy resource development in Malaysia along with an outlook for future energy sources. Malaysia is well endowed in energy resources which include oil, hydro, natural gas, and coal. However, at the current production rate, oil is expected to be exhausted in a matter of a few decades. The paper goes on to discuss coal utilization projects which were initiated in the late 1970's and early 1980's. This has resulted in coal demand increasing from 81,000 tons in 1980 to 2.15 million tons in 1990. The future of coal is discussed in light of the existing reserves and the economics of coal compared to other energy sources.

50376 (CONF-891185–1, pp. 11, Paper 13) **The United States and Asia: Pacific partners in coal and coal technology.** Grundy, T. Jr. (Dept. of Energy, Washington, DC (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper summarizes the current U.S. Department of Energy's policy on coal development and export to the Pacific Rim countries of the world. It provides a brief history of the U.S. coal industry and the U.S. role in world coal trade. It goes on to emphasize the stability and availability of coal as an energy supply source for these developing countries along the Pacific Rim. The author also provides special emphasis on the exporting of coal technology which would support U.S. coal sales. This technology deals with both environmental controls and efficiency in combustion.

50377 (CONF-891185–1, pp. 6, Paper 14) **U.S. coal production and export.** Dunn, A.M. (Dept. of Commerce, Washington, DC (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper elaborates on the stability and reliability of the U.S. coal industry as it relates to the export coal marketing countries. The U.S. coal industry has the highest productivity of any mines in the world with abundant transportation facilities to easily market this coal to counties along the Pacific Rim. The paper also emphasizes the lack of government control of the coal industry which allows more flexability for both the U.S. and any importing nation.

50378 (CONF-891185–1, pp. 3, Paper 21) **The role of coal in meeting Hawaii's power needs.** McQuain, R.K. (Hawaiian Electric Co., Inc., Honolulu (USA)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper is an outline which describes the present technologies and power sources utilized by the various Hawaiian Islands. It provides information of the type of fossil-fuel facility along with the generating capacity and type of generator at each. It provides an anticipated growth rate for electric power along with plans for installation of new coal-fired facilities. A brief history of coal for power generation in Hawaii is also provided.

50379 (CONF-891185–1, pp. 4, Paper 22) **Workshop on Asia-Pacific coal technology trade issues, November 16, 1989.** Kessler, R.L. (Western Coal Transportation Association, Denver, CO (USA)); Sarkus, T.A. East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper discusses the methods of achieving U.S. exports of clean coal technology and/or coal by effectively helping the developing countries of the Asia-Pacific region to meet their rapidly growing energy needs with the context of specific and local

technical, political, and economic requirements. It makes recommendations on how U.S. officials and coal marketers can best market their products and technology to these highly segmented coal-buying countries. This would include trade-team homework which would require specific details to be gathered about each countries needs and economic state. These details may include the applicability of various technologies to existing plants, site selection for the introduction of new technology facilities, the nature of locally available fuels, the potential for importing U.S. coal, and governmental concerns with respect to economic development in different areas. After the homework has been performed, trade teams should move in to negotiate with the respective officials. Based on these discussions, a comprehensive turn-key package can be developed and presented.

50380 (IEACR–26) **Coal supply prospects in the Asia/Pacific region.** Doyle, G. IEA Coal Research, London (UK). ©Aug 1990. 84p. Sponsored by International Energy Agency. Source: IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom.

The Asia/Pacific region produces and consumes around one quarter of the world's coal output. It includes large-scale producers, most notably China and India, and one nascent exporter, Indonesia. The region is a net coal importer, the most important consumers being Japan, South Korea and Taiwan, whose own coal industries are in decline. The fast growing and energy hungry economies of other countries in the region, such as Malaysia, The Philippines, and Thailand are also looking to coal to help meet their needs. The report covers all these countries together with the little known coal producers of North Korea and Vietnam. The current background and future prospects of each country are examined, with projections being made of production and trade up to the year 2000. 96 refs., 22 figs., 56 tabs.

0160 Health and Safety

Refer also to citation(s) 50348, 50354, 51881

02 PETROLEUM

Refer also to citation(s) 50522

50381 (CIM/PS–CE03173) **Applied vision: Realizing our potential: Volume 1.** Petroleum Society of CIM (Canada). 1988. vp. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Subjects of papers presented at a meeting of Canadian oil and gas producers included reservoir simulation, oil/gas industry economics, sour gas technology, steam injection of heavy oil deposits, horizontal wells, petroleum flow in porous media and in wellheads, gas lifts, hydraulic fracturing, oil pumping, gas plant maintenance, and enhanced recovery processes. Separate abstracts have been prepared for 35 papers from this volume.

50382 (CIM/PS–CE03173, pp. 11.1-11.12, Paper 89-39-11) **Sour gas technology in the 1990's.** Hyne, J.B. (Alberta Sulphur Research Ltd., AB (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Historically, the major benefit from sour gas production has been the hydrocarbon component; the sour (or hydrogen sulfide) component has been, until recently, viewed as a nuisance or worse. This situation has changed and is affecting the future direction of sour gas technology. The benefit factors in sour gas production include not only methane as the hydrocarbon component but also the condensate. The high demand for sulfur has increased the economic impact of the sulfur component of the gas, especially in the case of super sour gas reservoirs which were previously considered uneconomic. For Canada, a third benefit factor is the sale of sour gas production and processing technology, a field in which Canada is a world leader. The cost factors of sour gas production include the adverse well conditions - a combination of high pressure, high temperature, and corrosive environment - requiring development of special materials and techniques. As hydrogen sulfide content increases, sulfur deposition and two-phase behavior become more problematic, leading to such developments as the use of solvents to keep the sulfur in solution. An additional cost factor of increasing importance is environmental protection for avoiding the hazards of toxic hydrogen sulfide during drilling and transport and minimizing the impact from the sulfur produced. Finally, sour gas processing is expected to benefit from advances in such areas as industrial instrumentation and materials, process control, Claus process catalysts, use of oxygen in Claus technology, and storage, handling, and transport of the sulfur product. 41 refs., 2 figs., 2 tabs.

50383 (CIM/PS–CE03174) **Applied vision: Realizing our potential: Volume 2.** Petroleum Society of CIM (Canada). 1988. vp. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The subjects of papers presented at a meeting of Canadian oil and gas producers included gas condensate wells, fluid injection processes, hydraulic fracturing, well cementing, acidization, simulation studies, well test analysis, heavy oil properties, in situ combustion, formation damage, physical properties of petroleum, water influx, geomechanics, Canadian gas technology in international trade, reserves analysis, personnel management, financing, and research programs. Separate abstracts have been prepared for 40 papers from this volume.

50384 (CIM/PS–CE03175) **Applied vision: Realizing our potential: Volume 3.** Petroleum Society of CIM (Canada). 1988. vp. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Subjects of papers presented at a meeting of Canadian oil and gas producers included reservoir characterization, computer applications in reservoir analysis and well testing, leak detection and batch tracking in pipelines, corporate public relations, ethane supply and demand, scaling of enhanced recovery experiments, evaluation of enhanced recovery projects, cementing and plugging, drill fluid rheology, fracture characterization, well logging, corrosion protection in pipelines and gas gathering systems, test procedures for evaluating waterflooding performance, surfactants used in waterflooding, and interfacial activity in caustic flooding. Separate abstracts have been prepared for 33 papers from this volume.

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 51886

50385 (AEA-APS–0006) **An overview of kicking well computer models.** Element, D.J.; Wickens, L.M.; Butland, A.T.D. AEA Technology, Winfrith (UK). Apr 1990. 93p. Contract TA 93/22/494. Order Number DE91701231. Source: NTIS (US Sales Only), PC A05/MF A01.

In recent years a number of computer programs have been developed to simulate the behaviour and control of gas kicks taken while drilling. Program development projects continue at several research organisations. The simplest kicking well programs are intended for use in the teaching and demonstration of kick control techniques. These programs contain only basic mathematical

models. More advanced models are employed in the most sophisticated codes which may be used to investigate the effects of such physical phenomena as kick gas solubility in oil-based drilling fluids or the motion of free gas in the non-Newtonian drilling fluid. Some kicking well code development projects have been coupled with experimental programmes to provide data and correlations for inclusion in the codes. This paper provides an overview of the kicking well computer codes that have been described in the open literature. These codes are compared and contrasted with respect to the differing modelling capabilities, numerical approximations, solution methods, and the representation of physical effects using either physical models or correlations. The physical models employed are critically analysed, and an assessment is made of the likely effects of certain modelling and solution simplifications. (author).

50386 (CEC–17275K) **Spring Coulee area, Alberta. Geological study and acreage valuation.** Cumming Exploration Consultants Ltd., Calgary, AB (Canada). [1989]. 42p. (CE–03167). Source: PC Circumpacific Energy Corporation, Calgary, AB, CAN ; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A compilation is presented of papers on Canadian tunneling, mainly featuring original papers or those presented at a tunneling conference held in Niagara Falls in 1986. The topics of the papers include historical overviews, pressure tunnels for power plants, ground control in railway tunnels, design of underground structures, diversion tunnels for flood control dams, and geotechnical considerations for power plant tunnels. Separate abstracts have been provided for 2 papers from this compilation.

50387 (CIM/PS–CE03173, pp. 23.1-23.10, Paper 88-39-23) **Thermodynamic considerations for unsteady state gas permeametry.** Ruth, D.W. (GEOTECHnical Resources Ltd. (Canada)); Kenny, J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A numerical simulation of an unsteady state gas permeameter has been developed which takes into account non-ideal gas and thermodynamic (non-isothermal) effects. It is shown that these effects have a profound influence on the pressure response of the apparatus. Although some influences may be designed out, important effects associated with rock/gas interacting cannot be modified. These influences should be taken into account when analysing the data. The design of a permeameter apparatus should ensure that heat transfer is maximized between the gas and the rock. In order to check for non-isothermal behavior, the apparatus should be instrumented with accurate temperature measurement devices. 4 refs., 4 figs., 2 tabs.

50388 (CIM/PS–CE03173, pp. 25.1-25.15, Paper 88-39-25) **The analysis of laboratory fluid/flow displacement data to obtain relative permeability curves.** Ruth, D.W. (GEOTECHnical Resources Ltd. (Canada)); Nikakhtar, B.; Wong, S.; Mitchell, B.T.; McLeod, G. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The approaches to analysing unsteady state oil displacement experiments in order to determine relative permeability curves are reviewed. A new version of the Welge technique, which incorporates explicit functional forms for relative permeability, is developed. The sensitivity of the production and pressure history to the shape of the relative permeability curves is analysed. The influence of capillary pressure is then predicted by comparing results from the Welge technique and from the numerical simulator. The oil production and pressure histories of a water displacing oil relative permeability experiment has been found to be more sensitive to the shape of the oil relative permeability curve than to the water relative permeability curve. The oil production and pressure histories become more sensitive to the shape of the water relative permeability curve as the mobility ratio increases. Capillary pressure has a major influence on relative permeability experimental results. Uncertainty as to which phase contacts the production face of the core can lead to major errors in interpreting displacement experiments. 5 refs., 8 figs., 2 tabs.

50389 (CIM/PS–CE03174, pp. 52.1-52.16, Paper 88-39-52) **WELLTEST-NFR: A computerized process for transient pressure analysis of multiphase reservoirs with single, dual or triple porosity behaviour.** Aguilera, R. (Servipetrol Ltd. (Canada)); Song, S.J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

An integated, form-driven software package which performs both conventional and type curve transient pressure analysis of multiphase reservoirs with single, dual or triple-porosity behavior has been developed. The single or dual-porosity reservoir can be hydraulically fractured and thus the early behavior might be characterized by a 1/2 or 1/4 slope on a log-log crossplot of pressure difference vs time depending on the finite or infinite conductivity of the hydraulic fracture. The early time behaviour might be dominated by wellbore storage effects in which case the log-log plot will yield a straight line with a slope equal to 1.0. In the case of dual and triple-porosity systems the shape of the transition period is dependent on the assumption of restricted (pseudo steady state) or unrestricted (unsteady state) interporosity flow. The reservoirs can be infinite-acting, sealed or with constant pressure at the outer boundaries. Some of the key parameters calculated from the analysis include transmissibility, skin, wellbore storage, matrix storage, fracture storage, number of fractures intercepting the wellbore, size of the matrix blocks, fracture aperture, hydraulic fracture half-length, and distance to reservoir boundary. The package analyzes drawdowns, buildups, isochronal and falloff tests. It is complemented with specialized analyses and plots including Horner, superposition, Miller-Dyes-Hutchinson reservoir limit test, triple porosity, linear flow, and a Cartesian plot of pressure difference vs. time to evaluate wellbore storage effects. The basic equations for generating this package are presented together with various typical crossplots. 36 refs., 10 figs.

50390 (CIM/PS–CE03174, pp. 53.1-53.29, Paper 88-39-53) **Analysis of sequential formation testing and surge tests using new techniques.** Soliman, M.Y. (Halliburton Services (Canada)); Petak, K.; Christensen, J.; Centanni, R. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A model for analyzing tests under the spherical flow condition has been developed and applied to sequential formation testing. This technique involves plotting change in pressure (from original reservoir pressure) versus time (from start of drawdown) on logarithmic scale. The buildup part of the test should follow a straight line whose slope can be used to determine flow regime. Late time buildup data will follow slopes on the flow-buildup plot of −1, −3/4, −1/2, and −1.5 for radial, bilinear, linear, and spherical flow, respectively. Several sets of actual field data have been analyzed by using the technique. Data for the field examples were obtained from surge tests and a sequential formation test. Both radial and spherical flow were observed. Examples show that the technique may be easily applied to rapid calculation of permeability. The technique may be applied for a wide range of permeability values and chamber volumes. 16 refs., 17 figs., 5 tabs.

50391 (CIM/PS–CE03174, pp. 64.1-64.9, Paper 88-39-64) **Unsteady state water influx in naturally fractured reservoirs.** Aguilera, R. (Servipetrol Ltd. (Canada)). Petroleum Society of CIM

(Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The diffusivity equation for naturally fractured reservoirs represented by dual-porosity systems has been solved as a function of dimensionless times and dimensionless water influx for various ratios of aquifer to reservoir size. Results are presented in a similar format to the one used by Van Everdingen and Hurst (1949) in their classic solution for conventional single-porosity reservoirs. Unrestricted (transient) and restricted (pseudo-steady) interporosity flows have been taken into account. Results indicate that the use of conventional water influx equations in naturally fractured reservoirs can lead to significant errors. 8 refs., 4 figs.

50392 (CIM/PS–CE03174, pp. 78.1-78.13, Paper 88-39-78) **An integrated reserves administration and evaluation tool.** Joziasse, P. (Canterra Energy Ltd. (Canada)); Doorne, G. Van. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Canterra's Reserves Adminstration and Evaluation System (CRAES) was developed in response to two needs: to maintain a complete inventory of corporate hydrocarbon and sulphur reserves; and to generate realistic cash flows and values for those reserves. To be an effective management tool, the system also had to fulfill the following requirements: provide accurate and timely technical and financial management information; meet regulatory reporting requirements; make use of and be consistent with other corporate data such as land information, production history data, and budget and planning projections; and be cost effective and time efficient. Basic reservoir parameters, well data, oil and gas interests, and the most current production history data are maintained with CRAES to determine remaining recoverable hydrocarbons in every lease in which the company has an interest. An elaborate audit system permits detailed reporting of reserves and reserve changes resulting from discoveries, acquisitions, divestitures and technical re-evaluations. An economic evaluation of all remaining hydrocarbon and sulphur volumes is conducted regularly, using capital, operating cost and production projections from the production departments and price and escalation forecasts from the planning department. The resulting cash flow forecasts and reserve values are used by the finance and production departments for future planning. The CRAES database is integrated with other corporate databases and provides comprehensive management and reporting of corporate reserves. 7 figs.

50393 (CONF-9005183–, pp. 160-167) **Wave propagation in partially saturated porous media.** Miksis, M.J. (Northwestern Univ., Evanston, IL (USA)). Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-88ER13927. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Macroscopic equations are derived for wave propagation in a partially saturated porous medium. The author uses the method of homogenization. On the microscopic scale he accounts for both the dissipation due to viscosity and the dissipation due to contact line motion. 17 refs., 1 fig.

50394 (CPE–45952Q) **Reserve and economic evaluation. Oil and gas properties.** Chapman Petroleum Engineering Ltd., Calgary, AB (Canada). [1989]. 281p. (CE–03170). Source: PC Int'l Focus Res. Inc., 1210, 815 - 8th Avenue SW, Calgary, AB, CAN T2P 3P2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

International Focus Resources owns oil and gas properties in western Canada. Information is presented on the ownership interests, reserves, reservoir parameters, production, and economic parameters of each property along with appropriate maps. A total of 19 properties in Alberta and 1 each in British Columbia and Saskatchewan are covered. The economics presented in this report are in a condensed form for simplicity in analyzing the cash flows, and include product price forecasts, royalty provisions, capital expenditure and operating cost estimates, sales forecasts, and cash flows at undiscounted and various discounted rates (10%, 15%, 20%). The total proven plus probable reserves for oil, gas, and natural gas liquids are estimated at 384 Mbbl, 5498.6 million cubic feet, and 68,900 bbl respectively. Cumulative cash flow (undiscounted) is estimated at $2.7 million for proven producing reserves and $20.56 million for proven plus probable reserves. 21 figs., 71 tabs.

50395 (DOE/BC/14000–6) **An assessment of the reserve growth potential of the Frio Barrier- Strandplain Play in Texas.** ICF Resources, Inc., Fairfax, VA (USA); Texas Univ., Austin, TX (USA). Bureau of Economic Geology. Aug 1990. 128p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86BC14000. Order Number DE90000258. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report is part of a coordinated series of research efforts designed to prepare preliminary evaluations of important components of the domestic unrecovered oil resource. The specific resource is the oil that is displaceable by water and remains in the Nation's reservoirs after conventional production. Integrated geologic, engineering, and economic evaluations in this series estimate future reserve additions from this unrecovered mobile oil (UMO) resource under various circumstances. The individual studies (Volumes 2 through 5) consider the effects of changes in oil prices and advances in production technology on the economic recovery potential of the UMO resource. This report (Volume 1) discusses and compares the approaches and results of the individual studies. Several recovery technologies are evaluated, including the use of waterflooding in conjunction with infill drilling to displace and produce UMO at decreased well spacings. The overall analysis series was conducted in two separate, but coordinated, parts: at a detailed reservoir level and at a generalized regional level. At the reservoir level, detailed analyses of three individual Texas reservoirs fully delineated the resource and the potential for UMO recovery in each reservoir under a variety of development situations. At the regional level, reservoirs in three major oil producing states, Texas, Oklahoma, and New Mexico, were analyzed to determine the resource volume, potential recovery, and the costs and benefits associated with this recovery both in the individual states and for the region as a whole. This analysis relied on the geological classification of individual reservoirs, specific rock and fluid properties, and production and development histories to quantify the resource and to assess its potential for UMO recovery potential. 24 refs., 35 figs., 29 tabs.

50396 (GGU-R–143) **North Greenland stratigraphy and petroleum geology.** Groenlands Geologiske Undersoegelse, Copenhagen (Denmark). 1989. 72p. Order Number DE91707320. Source: NTIS (US Sales Only), PC A04/MF A01.

This collection of three papers presents results from the continuing work on the geology of the Franklinian and Wandel Sea basins in North Greenland initiated by the Geological Survey of Greenland (GGU). In the first article, the Morris Bugt Group (Middle Ordovician - early Silurian) is redefined and extended across North Greenland. New data on the ages of the formations based on conodont biostratigraphy are given, and correlations with Arctic Canada, East Greenland and Svalbard are discussed. A formal kithostratigraphic scheme for the Upper Palaeozic and Triassic succession of the Wandel Sea basin in central and eastern North Greenland, is erected and the depositional evolution during this period is described. The hydrocarbon source rock potential of some Silurian (Llandoverian) shales of the Peary Land Group from central and western North Greenland is discussed. The source rocks have TOC values between 2% and 6% (type II kerogen), and immature to early mature samples have high generative potential. However, most of the potential source area is thermally mature to

postmature leaving only few changes of finding trapped hydrocarbons with sources in these shales. (author).

50397 (GGU-R-143, pp. 5-20) **The Morris Bugt Group (Middle Ordovician - Silurian) of North Greenland and its correlatives.** Smith, M.P. (Department of Earth Sciences, University of Cambridge, Cambridge (GB)); Soenderholm, M.; Tull, S.J. Groenlands Geologiske Undersoegelse, Copenhagen (Denmark). 1989. In *North Greenland stratigraphy and petroleum geology.* 72p. Order Number DE91707320. Source: NTIS (US Sales Only), PC A04/MF A01.

The Morris Bugt Group, originally proposed in western North Greenland, is now extended across the whole of North Greenland. One new formation, the Kap Jackson Formation, is described; it includes two members, the Gonioceras Bay and Troedsson Cliff Members, which correspond to earlier formation of the same names. In the Washington Land - western Peary Land region the group comprises the Kap jackson, Cape Calhoun and Aleqatsiaq Fjord Formations. The Boerglum River and Turesoee Formations of the Peary Land - Kronprins Christian Land region are here added to the group. New data on the age of the formations based on conodont biostratigraphy are given, and correlations with Arctic Canada, East Greenland and Svalbard are discussed. (author) 64 refs.

50398 (GGU-R-143, pp. 21-45) **Stratigraphy and depositional history of the Upper Paleozoic and Triassic sediments in the Wandel Sea Basin, central and eastern North Greenland.** Stemmerik, L. (Geological Survey of Greenland, Copenhagen (DK)); Haakansson, E. Groenlands Geologiske Undersoegelse, Copenhagen (Denmark). 1989. In *North Greenland stratigraphy and petroleum geology.* 72p. Order Number DE91707320. Source: NTIS (US Sales Only), PC A04/MF A01.

A lithostratigraphic scheme is erected for the Lower Carboniferous to Triassic sediments of the Wandel Sea Basin, from Lockwood ϕ in the west to Holm Land in the east. The scheme is based on the subdivision into the Upper Carboniferous - Lower Permian Mallemuk Mountain Group and the Upper Permian - Triassic Trolle Land Group. In addition the Upper Carboniferous Sortebakker Formation and the Upper Permian Kap Kraka Formation are defined. Three formations and four members are included int he Mallemuk Mountain Group. Lithostratigraphic units include: Kap Jungerson Formation (new) composed of interbedded limestones, sandstones and shales with minor gypsum - early Moscovian; Foldedal Formation compsed of interbedded limestones and sandstones - late Moscovian to late Gzhelian; Kim Fjelde Formation composed of well bedded limestones - late Gzhelian to Kungurian. The Trolle Land Group includes three formations: Midnatfjeld Formation composed of dark shales, sandstones and limestones - Late Permian; Parish Bjerg Formation composed of a basal conglomeratic sandstone overlain by shales and sandstones - ?Early Triassic (Scythian); Dunken Formation composed of dark shales and sandstones - Triassic (Scythian-Anisian). The Sortebakker Formation (new) is composed of interbedded sandstones, shales and minor coal of floodplain origin. The age is Early Carboniferous. The Kap Kraka formation (new) includes poorly known hematitic sandstone, conglomerates and shales of Lat Permian age. (author) 34 refs.

50399 (GGU-R-143, pp. 47-71) **The Silurian shales of central and western North Greenland: evaluation of hydrocarbon source rock potential.** Christiansen, F.G. (Geological Survey of Greenland, Copenhagen (DK)); Noehr-Hansen, H. Groenlands Geologiske Undersoegelse, Copenhagen (Denmark). 1989. In *North Greenland stratigraphy and petroleum geology.* 72p. Order Number DE91707320. Source: NTIS (US Sales Only), PC A04/MF A01.

The Silurian shales of central and western North Greenland form a more than 400 m thick succession which contrains some potential hydrocarbon source rock intervals. Deposition of these organic-rich units was restricted in both time and space and potential source rocks only formed when and where black shales covered wide areas of shallow-water carbonates. Such deposition started in the middle Llandovery in Washington Land and continued thoughout the region in the late Llandovery. Neither the Wenlock nor the Ludlow shales contain sufficient organic matter to be considered as potential source rocks. The potential source rocks are dominated by oil-prone organic matter (large amorphous kerogen particles, mainly type II) and typically show TOC values between 2% and 6%. The generative potential of immature to early mature samples is high with values up to 30 mg HC/g rock. A drastic increase in thermal maturity of surface rocks is observed form south to north and most of the potential drainage area is thermally mature to postmature. This leaves only few changes of finding trapped hydrocarbons sourced by Silurian shales in North Greenland. (author) 29 refs.

50400 (NBU-89-1) **Geology of the Stoney Creek Oil and Gas Field, and its implications regarding the tectonic evolution of the eastern Moncton Subbasin, New Brunswick.** Foley, S.L. New Brunswick Univ., Fredericton, NB (Canada). 1989. 90p. (MICROLOG-90-03187). Source: PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $14.00 CAN; MF $10 CAN.

The Stoney Creek Oil and Gas Field is an historic but still-producing field in the Late Paleozoic Moncton Subbasin of New Brunswick. Hydrocarbons are trapped within shoreface sands of the Lower Carboniferous Alberta Formation. The lacustrine shales and siltstones of the Alberta Formation thicken down-dip towards the south across the Stoney Creek field. Sandstone sequences interbedded with the shales and siltstones also thicken towards the south and presumably into the deeper part of the Moncton Subbasin. The thickening of the Albert Formation away from the Westmorland Uplift indicates that the uplift, which lies directly north of the field, acted as a passive high. Lower Carboniferous facies distributions, paleocurrent patterns and high-resolution seismic profiles indicate that the major source area for the sediments in the eastern Hillborough subbasin (southeastern Moncton Subbasin) was the Westmorland Uplift. The Moncton Fault is a large regional fault which is located north of the Westmorland Uplift along the east-west arm of the Petitcodiac River. This fault had a large north-side-down component of movement. A thick sequence of Lower Missipippian sediments accumulated in the Petitcodiac Subbasin (northeastern Moncton Subbasin) to the north of the Moncton Fault. A tectonic model for the eastern Moncton Subbasin is advanced based on the interpretation of seismic profiles, known displacements of exposed regional faults and the types and distribution of Upper Devonian and Lower Carboniferous clastic facies. From the evidence, it is believed that the Moncton and Sackville subbasins formed synchronously as en echelon pull-apart basins in response to right lateral strike-slip tectonics. Directions for further hydrocarbon exploration in the Moncton Subbasin are suggested. 59 refs., 22 figs.

50401 (NE-1988-03) **Significant discoveries offshore Newfoundland and Labrador. Update 1988-03.** Newfoundland Dept. of Energy, St. John's, NF (Canada). 1988. 53p. (MICROLOG-90-03588). Source: PC Newfoundland Dept. of Energy, P.O. Box 4750, Atlantic Pl., Water St., St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Data are presented concerning oil and gas discoveries in the Newfoundland and Labrador offshore areas. Information includes a table of drillstem test results, a generalized geologic cross-section, flow rates for liquids (oil, gas, condensate, formation water), and well data such as location, status, depth, and spud date. Brief discussions are also provided on the commercial potential of each well. 24 figs., 22 tabs.

50402 (SAND-90-2068) **Fractures and stresses in Bone Spring sandstones: 1989 annual report.** Lorenz, J.C.; Warpinski, N.R.; Sattler, A.R.; Northrop, D.A. Sandia National Labs., Albuquerque, NM (USA). Sep 1990. 157p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE91000484. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This project is a collaboration between Sandia National Laboratories and Harvey E. Yates Company being conducted under the auspices of the Oil Recovery Technology Partnership. The project seeks to appiy perspectives related to the effects of natural fractures, stress, and sedimentology to the simulation and production of low-permeability gas reservoirs to low-permeability oil reservoirs as typified by the Bone Spring sandstones of the Permian Basin,

southeast New Mexico. This report presents the results and analysis obtained in 1989 from 233 ft of oriented core, comprehensive suite of logs, various in situ stress measurements, and detailed well tests conducted in conjunction with the drilling of two development wells. Natural fractures were observed in core and logs in the interbed carbonates, but there was no direct evidence of fractures in the sandstones. However, production tests of the sandstones indicated permeabilities and behavior typical of a dual porosity reservoir. A general northeast trend for the maximum principal horizontal stress was observed in an elastic strain recovery measurements and in strikes of drilling-induced fractures; this direction is subparallel to the principal fracture trend observed in the interbed carbonates. Many of the results presented are believed to be new information for the Bone Spring sandstones. 57 figs., 18 tabs.

50403 **A study of the morphologies and inversions of model oilfield dispersions.** Smith, D.H. (U.S. Dept. of Energy (US)); Lim, K.H. *SPE (Society of Petroleum Engineers) Production Engineering (USA)*, 5(3): 265-269 (Aug 1990).

Using the surfactant/oil/water system $C_4H_9OC_2H_4OH$/n-$C_{10}H_{22}$/brine (0.01-M NaCl) and electrical-conductivity measurements, the authors have determined the emulsion morphologies and the phase volume fractions at which inversion occurred at temperatures below the lower critical endpoint temperature and above the upper critical endpoint temperature. In both cases, inversion occurred at 45 ± 5 vol% internal phase when that phase was the water-rich phase and at 60 ± 5 vol% internal phase when that phase was the oil-rich phase. These results contradict the correlation between phase behavior and emulsion morphology that has been almost universally reported in the oil-recovery literature, but are in much better agreement with models for emulsion inversion that are based on packing arguments.

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Refer also to citation(s) 50385, 50395, 50403, 50523, 50525

50404 (CIM/PS–CE03173, pp. 1.1-1.21, Paper 88-39-01) **Calculation of flowing well pressures in reservoir simulation using nine-point differencing.** Shiralkar, G.S. (Amoco Production Co. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A quantity of considerable importance in flow rate predictions in reservoir simulation is the equivalent well block radius, r_o, because it directly relates the numerically calculated grid block pressure to the actual well flowing pressure. Simulation of steam and miscible floods generally requires nine-point differencing. Previous work on approximating r_o for nine-point differencing either has severe limitations or can give erroneous results and hence incorrect rate predictions. A rigorous, closed form expression is presented for r_o for an isolated well, valid for any nine-point method. This expression is based on mathematical analysis and confirmed by careful numercial testing. It identically reduces to the expression for five-point differencing (obtained earlier by Peaceman, 1987) as a special case. Extension is made to the anisotropic case and confirmed numerically. Results for some additional well geometries are also presented for the case of nine-point differencing. These include arbitrary location of a well in the well block, multiple wells within a single block, and a well in an edge or corner block. Finally, effects of heterogeneity on predicting flow rates are considered. 15 refs., 7 figs., 9 tabs.

50405 (CIM/PS–CE03173, pp. 2.1-2.13, Paper 88-39-02) **The Symbolic D4 method for reservoir simulation.** Oguztoreli, M. (Petro Simulator Systems Inc. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A cost-limiting factor of numerical reservoir simulation is the execution time spent on solving large systems of equations. The Symbolic D4 method is a new direct solver which uses less memory and is significantly faster than other direct methods. This method decomposes the coefficient matrix symbolically, based on the structural patterns generated by D4 ordering. The reduced system occupies a single quadrant of the original matrix, requiring fewer floating point operations to be solve. Execution time and memory requirements are compared between the Symbolic D4 method and band algorithm using PCSIM Version 1.0, a three-phase, three-dimensional black oil simulator for the IBM PC. One, two and three-dimensional applications are investigated. It is shown that the Symbolic D4 method is many times faster than the band algorithm, while using a fraction of the memory. Performance also improves with increasing grid size, making the Symbolic D4 method ideally suited for multi-dimensional simulation on smaller computers with memory and/or speed limitations. Larger grids can be addressed and results obtained more rapidly. An example of simulation results is presented for the case of an undersaturated heterogeneous reservoir which is partially depleted under both fluid expansion and solution gas drivers. 4 refs., 4 figs., 3 tabs.

50406 (CIM/PS–CE03173, pp. 22.1-22.17, Paper 88-39-22) **The potential for horizontal wells for petroleum production.** Butler, R.M. (Univ. of Calgary, AB (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Horizontal wells drilled as deviated wells from the surface can improve the efficiency and economy of oil recovery operations. Rapid development in this area is being spurred by improved drilling technology which allows more favourable economics. It is indicated that horizontal wells may deliver 2-10 times the performance of conventional wells while costing, under favorable circumstances, less than twice as much. The improvement offered by horizontal wells results from their more extensive contact with the reservoir. This allows lower fluid velocities at the well bore while still providing total flows which are economic. This advantage over conventional wells can be exploited in several ways. Specific applications where horizontal wells can have advantages are described. The best applications of horizontal wells are those where conventional wells would normally be employed with very close spacing. Conventional wells which produce at low rates can be replaced by fewer horizontal wells for the same performance, or improved performance can be achieved by using the same number of wells. Reservoirs which contain natural fractures and/or large voids are particularly suited to development using horizontal wells, in that a long horizontal well bore will probably intersect more of the high productivity features. Water or gas coning, can be reduced by the use of horizontal wells as a result of the lower near well-bore fluid velocities for the same total flow. Horizontal wells can also provide better gas/oil and water/oil ratios in circumstances where, because of high oil viscosity, operation at above the critical production rate is necessary for economic reasons. A particularly attractive application of horizontal wells lies in their use with steam recovery. High production rates appear possible without steam cresting. 29 refs., 12 figs.

50407 (CIM/PS–CE03173, pp. 24.1-24.16, Paper 88-39-24) **Multi-phase multi-component isenthalpic flash calculations with a cubic equation of state.** Agarwal, R.K. (Computer Modelling Group (Canada)); Yau-Kun Li; Nghiem, L.X.; Coombe, D.A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Typical applications of isenthalpic flash calculations in reservoir engineering include predictions of steam-distillation mechanisms in steamfloods and phase separation in wellbores. The predictions of vaporization and condensation phenomena in these processes entail the determination of phase mole (and volume) fractions and compositions as well as the mixture temperature given the pressure, composition and enthalpy of the feed. The equations for isenthalpic flash calculations with cubic equation of state are presented. Two methods for solving these equations are discussed. The complexities associated with isenthalpic flash calculations that do not exist in isothermal flash calculations are highlighted. The first method (Scheme 1) involves a series of isothermal flash calculations at different temperatures until the energy balance equation is satisfied. In the second method (Scheme 2), the energy and material balance equations are updated simultaneously to obtain the temperature and phase splits. These are then used to update the equilibrium ratios (K-values). This process is repeated until convergence is achieved. Scheme 1 cannot handle systems for which the degree of freedom from the phase rule equals unity. Both schemes are extensively tested. The results show that Scheme 1 is more robust that Scheme 2 but is about three times slower. A hybrid scheme is devised to take advantage of both the robustness of Scheme 1 and the speed of Scheme 2. 5 refs., 4 figs., 2 tabs.

50408 (CIM/PS–CE03173, pp. 26.1-26.14, Paper 88-39-26) **Correlations developed to predict two phase flow through wellhead chokes.** Abdul-Majeed, G.H. (Univ. of Baghdad (Iraq)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The predictive accuracy of eight critical two-phase flow correlations are tested against field measured production data, from 210 well tests, covering a broad range of production rates, choke sizes, upstream pressures, gas-liquid ratios and oil gravities. Test data are divided into four selected categories based on choke size. The correlations included in this study are those of Gilbert (1954), Ros (1959), Baxendall (1957), Achong (1961), Poettmann and Beck (1963), Omana (1968), Ashford (1974), and Hazim-Ghassan (1985). The average percent error, absolute average percent error, and standard deviation are computed for each correlation. Due to inconsistency of results obtained by the included correlations, multiple regression analysis was used to find out correlations that best fit the measured data. As a result, four new correlations were developed which proved to be accurate models for predicting flow rates. Based on the statistical results, the new correlations clearly outperformed the remaining correlations. Sample calculations using the correlations are included. 14 refs., 5 figs., 3 tabs.

50409 (CIM/PS–CE03173, pp. 27.1-27.18, Paper 88-39-27) **Economical distribution of gas in a continuous gas-lift system subject to variable cost and system constraint.** Zheng-Gang, X. (Norwegian Inst. of Technology (Norway)); Herfjord, H.J.; Ramstad, H.J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A new approach is presented for the optimization of a continuous flow gas lift system. A model was developed which considers the effects on the gas lift design of variable operation costs of individual wells, limited lift gas availability, limited liquid handling capacity, and limited gas separation capacity, resulting in maximum daily income. The advantages of this model are as follows: the impacts of variable operation costs on the distribution of lift-gas to individual wells and on the economy of gas lift can be readily analyzed; the system constraints can be easily incorporated in determining the optimum distribution scheme for the gas lift system; and, sensitivity analysis constraints and the production characteristics can be systematically made. A procedure is also given for sizing surface processing capacities. This model was developed in the context of designing a continuous flow gas lift system for a North Sea field. An example problem consisting of four gas lift wells was solved to show the solution procedure involved in the model. 12 refs., 8 figs., 5 tabs.

50410 (CIM/PS–CE03173, pp. 28.1-28.11, Paper 88-39-28) **Optimizing electric submersible pump replacement costs.** Kupsch, N.W. (Amoco Canada Petroleum Co. Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Electric submersible pumps (ESPs) have made a significant contribution to the petroleum industry as an economic means of artificial lift. As current depressed oil prices linger, it has become especially critical that costs associated with operating ESPs be kept to a minimum. One method which has resulted in a great deal of success for Amoco Canada has been qualifying used motors and pumps for re-use through cleaning and testing procedures. At Amoco's operations in two large Alberta oil fields, the South Swan Hills Unit and the Nipisi Gilwood Unit No. 1, a total of 230 ESPs are in service. As ESPs fail downhole, equipment is examined for potential testing application. To the end of February 1986, 225 pumps have been cleaned and tested while 117 motors have also been put through the test program. A high requalification rate and inexpensive testing cost have combined for substantial savings over traditional repair procedures. The success of the program has been further enhanced by encouraging ESP performance from equipment rerun subsequent to being cleaned and tested. 1 refs., 4 figs., 3 tabs.

50411 (CIM/PS–CE03173, pp. 29.1-29.18, Paper 88-39-29) **Fracturing with crosslinked gelled methanol: A new approach to well stimulation.** Jabs, W. (BJ-Titan Services (Canada) Ltd. (Canada)); Grisdale, J.; Hossaini, M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Recent development of a water free fracturing fluid has improved well stimulation performance in several Alberta formations. Methanol has been used for many years to reduce formation damage caused by swelling clays and capillary blockage resulting from high fluid surface tension. The development and field application of the gelling and crosslinking of commerically available methanol is discused along with the rheological characteristics of the crosslinked gelled methanol system under dynamic conditions. The relative effects of both intensity and duration of shear that is applied during the preparation of the system are presented. Several factors inherent in the evaluation of a fracturing fluid for field application are noted. These include proppant transport capability, fluid leak-off coefficients, compatibility with carbon dioxide and safety in handling of a potentially volatile fluid. Case history data on the zones treated as well as post frac production results are included. 12 refs., 8 figs., 5 tabs.

50412 (CIM/PS–CE03173, pp. 3.1-3.11, Paper 88-39-03) **Limiting aspects of automatic history matching.** Farouq Ali, S.M. (Univ. of Alberta, Edmonton, AB (Canada)); Berkowitz, B.S. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

In principle, it now possible to generate more reliable reservoir development strategies than can be formulated via empirical,

largely intuitive, history matching. High-speed computational capabilities make it feasible to proceed from sophisticated mathematical models, and to seek a match of the observed reservoir performance by recourse to efficient numerical algorithms and iterative adjustment of input data. A summary is presented of a study of two currently prominent history-matching algorithms, one developed by Coats et al. (1970) and the other by Veatch and Thomas (1971). In addition, the existence of alternative approaches to solving the inverse problem for analogous, but less complex, situations is noted. The most serious problem encountered in automatic history matching is the tendency to construct ill-conditioned systems of equations of the type Ax=b. The least squares linear programming approach of Coats et al. is satisfactory under certain conditions, but is not entirely reliable or effective, mainly because it assumes a linear functional dependence of the matching errors on the reservoir description parameters. The direct approach of Veatch and Thomas appears to be practical only where very accurate pressure measurements are at hand. It would seem that the current automatic history matching methods are less than satisfactory. Such methods are simply not competitive with manual techniques used by experienced reservoir engineers. Effective and reliable solutions to the problem of automatic history matching require development of improved methods for estimating the geological structure and properties of the reservoir, and/or adaptation of sophisticated mathematical techniques to provide for a more thorough theoretical treatment of the entire problem. 6 refs., 2 figs., 5 tabs.

50413 (CIM/PS–CE03173, pp. 30.3-30.19, Paper 88-39-30) **A practical approach to correctly executing, hydraulic fracture treatments.** Smith, B.S. (Dome Petroleum Ltd. (Canada)); Moreland, B.T.; Hagel, M.W. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Creation of a fracture in a reservoir of design length and conductivity requires that the assumptions supporting the design be validated in the field and the fracture redesigned if necessary. The tools and methods available to undertake this validation are simple and effective, minimizing risk of premature sandoff or inadequate fracture length and conductivity. Recommended practices for use in the effective execution of hydraulic fracture treatments are presented. These practices outline the minimum standards that apply at different levels of investment and risk: a minimum fracturing standard for a low-risk low-cost infill well; a standard emphasizing practical technology, for a moderate cost well or regional control well requiring on-site data acquisition and design review; and a standard utilizing all available technology, for a high-cost or high-risk well. Under each practice are outlined procedures for reservoir and fracture modelling, fracture excution, and follow-up. Pre-face testing, and mini-frac testing for high-cost/high-risk wells is also discussed. 12 refs., 6 figs., 1 tab.

50414 (CIM/PS–CE03173, pp. 38.1-38.28, Paper 88-39-38) **Simulation study and technical evaluation of the Fenn-Big Valley South Lobe (D-2A) hydrocarbon miscible flood.** Todd, M.R. (Todd, Dietrich and Chase, Inc. (Canada)); Asgarpour, S. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Fenn-Big Valley South Lobe D-2A hydrocarbon miscible flood has been on stream since February 1983. The pool, located northeast of Calgary, Alberta, had effectively watered out under a primary natural water drive mechanism prior to the miscible flood with a recovery of 47.5% of the original oil-in-place. Performance of the pool under hydrocarbon miscible flood suggests an incremental oil recovery of 15% by the tertiary flood. After four years of the miscible flood, sufficient data became available to conduct a simulation study of the pool. The objective of this study was to describe the interaction of the miscible flood process and the reservoir geology in a region of the South Lobe having similar characteristics to those of the main Fenn-Big Valley D-2A pool. The motivation behind the simulation study and technical evaluation was the desire to extend the recovery process to a much larger part of the Fenn-Big Valley D-2A pool. The historical performance of the primary natural water drive and the first four years of solvent injection were reproduced with a fair degree of accuracy by a simulation model of one pattern element within the current enhanced recovery project area. The miscible flood description which resulted in the best fit of the observed pattern flood performance depicts a displacement that is characterized by both modest gravity override and modest viscous instabilities. 6 refs., 23 figs.

50415 (CIM/PS–CE03173, pp. 39.1-39.26, Paper 88-39-39) **Potential of non-thermal methods for heavy oil recovery.** Selby, R. (Husky Oil Operations Ltd. (Canada)); Alikhan, A.A.; Farouq Ali, S.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Recovery of moderately viscous (below 2000 millipascal-seconds) oils from reservoirs which are unsuitable for thermal treatment may be possible by non-thermal methods. Many heavy oil reservoirs in Canada fit this category: they are too thin, deep, or oil saturation is too low, or have other undesirable features for a thermal recovery method to be successful. A number of non-thermal methods are considered within the framework of field and laboratory experience, including improved waterfloods, polymer flooding, surfactant, caustic and other chemical floods, immiscible carbon dioxide flooding, and solvent flooding. Ranges in oil recovery as based upon field experience and from laboratory experiments are indicated. It is shown that non-thermal methods may be successful for heavy oil recovery under rather restrictive conditions. Based upon the data from some 113 field tests, it seems that immiscible carbon dioxide floods are more likely to be successful. In nearly all cases, the oil recovery is much lower than that attainable by thermal methods. Also, the oil recoveries obtained in the laboratory are much higher than field recoveries for a given process. 132 refs., 4 figs., 5 tabs.

50416 (CIM/PS–CE03173, pp. 4.1-4.12, Paper 88-39-04) **Numerical simulation of foam flow in porous media.** Islam, M.R. (Petroleum Recovery Inst. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A new mathematical formulation is presented which provides a realistic and appropriate representation of foam behavior in a porous medium. This formulation explains the blocking mechanism of foam in the presence of oil and water, and was developed within the framework of 3-phase, 3-dimensional flow. The model equations are typical of oil-water-gas systems. The mathematical model was tested against experimental results showing good agreement. 19 refs., 6 figs., 2 tabs.

50417 (CIM/PS–CE03173, pp. 40.1-40.9, Paper 88-39-40) **Foam forming surfactants in Pembina/Ostracod G Pool.** Chad, J. (Signalta Resources Ltd. (Canada)); Matsalla, P.; Novosad, J.J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A coinjection of small amounts of brine containing foam-forming surfactants seems to be a promising technology for alleviating gas

injection problems related to the unfavorable mobility ratio of injected gas and displaced fluids. An application of foam-forming surfactants was developed for use in a gas flood in the Pembina Ostracod G Pool in west-central Alberta. A displacement apparatus was used in laboratory tests to evaluate various surfactants suitable for the field conditions at the pool. The mobility reduction factor, or the ratio of pressures measured across the length of the core sample during simultaneous injection of the liquid and gas phases, was selected as the best quantity for a relevant comparison of surfactants. A field test was then designed using Dow Pusher XSS84321.11 surfactant which was injected simultaneously with the natural gas stream. The test was intended to establish the injection profile of the gas injection well prior to injecting surfactant, to determine whether surfactant and lean natural gas can be injected simultaneously into the reservoir, and to determine if the surfactant is effective at reducing the mobility of the injected gas at field conditions. The results appear to indicate that the surfactant does act to reduce the mobility of the injected gas. The magnitude of the deviation from the baseline injection profile was not as large as anticipated from the laboratory tests. Oil production from the pool increased from an average of 25 m^3/d to 33 m^3/d for the 3 months following addition of the surfactant solution to the injected gas. Further field tests are needed to confirm the validity of this observation. 3 refs., 9 figs., 1 tab.

50418 (CIM/PS–CE03173, pp. 5.1-5.25, Paper 88-39-05) **An evaluation of the improved dual porosity model for the simulation of gravity effects in naturally fractured reservoirs.** Fung, L.S.K. (Computer Modelling Group (Canada)); Collins, D.A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The accurate representation of the interactions between matrix and fracture in the dual porosity model is crucial to the proper prediction of recovery from fractured petroleum reservoirs. In the standard dual porosity model, matrix-fracture transfer is represented by a single term in the mass balance equations, and the matrix-matrix flow is assumed to be negligible. This was found to be inadequate when gravity effects are important. Various methods were reported in recent literature which account for the gravity drainage process. These include the gravity segregated model, the subdomain method, and the dual permeability model. The gas-oil gravity drainage process is examined and the different approaches for solving this problem are evaluated. Simulation runs using the various models were made for the same gravity drainage test problem. The dual permeability model was found to be the most rigorous in handling the gravity drainage problem and can account properly for inter-matrix-block flow. 13 refs., 16 figs., 4 tabs.

50419 (CIM/PS–CE03174, pp. 43.1-43.22, Paper 88-39-43) **Design of a field-wide hydrocarbon miscible flood for the Kaybob Beaverhill Lake A Pool.** MacLean, D.A. (Chevron Canada Resources Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Kaybob Beaverhill Lake A Pool is located 150 miles northwest of Edmonton, Alberta. Plans are to convert from a horizontal patterned waterflood to a horizontal water alternating gas (WAG) patterned hydrocarbon miscible flood in 1988. The proposed Kaybob miscible flood project is described with emphasis on selection of well pattern and infill well location, forecasting the remaining oil recovery due to the existing waterflood, forecasting the incremental oil recovery due to infill wells, forecasting tertiary oil recovery, and the miscible solvent design. Ultimate oil recovery was derived by combining the estimated remaining secondary oil recovery under a continued waterflood with the estimated ultimate tertiary oil recovery under a hydrocarbon miscible flood. Tertiary oil recovery was derived in a parametric analysis using a Todd-Longstaff type miscible flood simulator. Over 200 models were run with the simulator to describe vertical and areal sweep efficiency throughout the miscible flood target area. The tertiary oil recovery versus pore volume injected schedules from the areal model were combined with the vertical sweep efficiency constant in an arithmetic forecast model to obtain a pattern by pattern tertiary oil production forecast for any given solvent injection volume or rate. Ultimate oil recovery under a continued waterflood from the Kaybob pool is estimated at 17.12 by $10^6 m^3$ or 38.6% of the original oil in place (OOIP). Ultimate oil recovery for a hydrocarbon miscible flood with 24 infill wells is estimated at 22.6 $10^6 m^3$ or 50.9% or the OOIP. 6 refs., 9 figs., 6 tabs.

50420 (CIM/PS–CE03174, pp. 44.1-44.16, Paper 88-39-44) **Waterflooding in a small pinnacle reef reservoir with a single wellbore.** Boutette, M.J. (Ultramar Oil and Gas Canada Ltd. (Canada)); Ko, S.C.M.; Withers, R.L. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The feasibility of implementing a pressure maintenance scheme in a small pinnacle reef reservoir in the Shekilie area of northwestern Alberta was assessed. Detailed geological and reservoir simulation studies were conducted on the single well Shekilie Keg River III Pool to investigate the alternatives for enhanced oil recovery in a pinnacle reef oil reservoir, with less than one million barrels of oil in place originally. An excellent history match of the primary production performance by a simulation model provided a sound basis for studying different pressure maintenance schemes at various stages of primary depletion. A single-well waterflood recovery scheme was recommended for the pool, and susequently implemented in October of 1987. Actual field production and injection performance of this scheme demonstrate that effective enhanced recovery by waterflooding can be achieved using a single wellbore in a small pinnacle reef oil reservoir. 5 refs., 12 figs., 5 tabs.

50421 (CIM/PS–CE03174, pp. 45.1-45.40, Paper 88-39-45) **Fracture characterization of the Wainwright Pool.** Baker, R. (Huskey Oil Operations Ltd. (Canada)); Gregor, V. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Wainwright field in the Alberta Lloydminster District has produced medium gravity oil under waterflood from roughly 700 inverted 9-spot pattern wells, since the early 1960s. The formation is a moderately consolidated, thin Sparky sandstone. Initially water breakthrough did not show any preferential direction. However in recent years, production performance has been dominated by the effects of fractures between injecting and producing wells. It was apparent that a new waterflood management strategy was needed to optimize ultimate recovery and arrest declining productivity. An investigation of fracture characteristics was done by conducting interwell tracer tests, pressure pulse tests and fall off tests as well as analyzing production data. Results confirmed very rapid communication between ontrend wells. From this work, it was found that fractures were orientated on a northeast-southwest tectonic stress trend and propagation closure was largely dependent on injection rates. There was no definitive fracture pressure. The long term solution was identified as field wide conversion from inverted 9-spot to line drive in order to optimize ultimate recovery and take advantage of the fracture system. A short term solution to maintain current levels of production was to reduce high injection rates. By understanding the reservoir and compensating for it, high recovery will occur despite fractures and high oil viscosity. 27 refs., 30 figs., 1 tab.

50422 (CIM/PS–CE03174, pp. 46.1-46.23, Paper 88-39-46) **Case study: Development and optimization of Petro-Canada's Valhalla Doe Creek I Pool.** Astete, E.L. (Petro-Canada Resources (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Valhalla Doe Creek I Pool is a hydrocarbon bearing marine sand deposition of Upper Cretaceous age located in northwestern Alberta. It is 750 m deep and contains 12.4 million m^3 original oil-in-place (OOIP). The pool was discovered in 1981 and the primary development was completed in 1984. A 32-hectare 5-spot waterflood scheme comprised of 43 producers and 38 injectors was implemented in mid 1985. The current oil production rate is 200 m^3/d and cumulative recovery is 2.3% of the OOIP. Additional infill drilling is planned to convert to a 16-hectare 5-spot and 9-spot in 1987/1988. From the early stage of the pool's development, reservoir and geological data were gathered and reviewed. Numerous routine and special core studies were performed. Standard analysis procedures were employed to determine porosity, permeability, relative permeability, capillary pressure, fluid saturation and pressure-volume-temperature (PVI) properties. In addition, several studies (scanning electron microscopy, water compatibility, fines migration, and emulsion) were conducted to predict the reservoir sensitivity to injection water. A 3-dimensional numerical model (Black Oil) was constructed using the validated data. The model, in conjunction with a financial simulator, was used to determine the optimum development scheme for this pool. 9 refs., 17 figs.

50423 (CIM/PS–CE03174, pp. 47.1-47.16, Paper 88-39-47) **Utilizing a field computer system during cementing to help avoid costly workovers.** Purvis, D. (BJ-Titan Services (Canada)); Gregory, G. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The need for costly workover operations can be reduced by accurately monitoring and modelling well cementing operations with a field computer system. In the application described, computer monitoring is used to detect down hole problems prior to and during cementing, increase quality control, and maintain proper equivalent circulating densities to assist in avoiding lost circulation and/or influx. The computer monitoring system used consists of transducers on the pumping and return lines, a data acquisition system, and a microcomputer with various peripherals. The computer uses data from the transducers to calculate and display information on the position of each fluid in the borehole, flow regime, equivalent circulating density, well pressures, and fluid inventories. Before cementing, a design program is run to simulate the operation and determine potential problems. By monitoring circulation before cementing, additional potential problems can be detected and corrected. The real-time computer model uses the procedure for calculating frictional pressure outlined in the American Petroleum Institute specification 10, Appendix J(1). 7 refs., 17 figs.

50424 (CIM/PS–CE03174, pp. 48.1-48.11, Paper 88-39-48) **Selective acid washing technique for improved oil production from the Youngstown Field in Alberta.** Archibald, A.D. (Suncor Inc. (Canada)); Farquharson, J.G. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A new selective acid washing tool has been developed for application in stimulating the Arcs member of the Nisku formation in the Youngstown Field of Alberta. Case histories and recommendations are provided as to the wide ranging adaptability of the acidizing method. Acid stimulation in the Arcs member had, in the past, consisted of batch washes until the zone would no longer hold a fluid column. Recent recompletions had resulted in the need for a method of selectively acid washing to ensure that new perforations were open to allow inflow. Selectively squeezing acid into the formation was not recommended due to a limited pay zone and the proximity of an underlying aquifer. Premature watering out of wells had historically been a problem due to acid squeezing. A tool capable of washing selected pay in discrete intervals while isolating remaining pay from fluid contact was not available from the current selection of well service tools. The new selective acid wash tool was constructed as a simple arrangement of opposing cups with virtually no mechanical manipulations required for operation. The design simplicity kept acidizing time to a minimum. An infill drilling program in 1987 utilized selective acid washing techniques on the initial completions which identified a marked improvement. A comparison of initial stabilized production rates from 20 wells at Youngstown showed that an average productivity gain of 0.3 m^3 per porosity-meter was possible by selective acid washing over batch acid washing. The long term benefits of selective acid washing at Youngstown cannot be quantified at the present time; however, productivity gains after one year of production are still apparent. 4 refs., 7 figs.

50425 (CIM/PS–CE03174, pp. 49.1-49.19, Paper 88-39-49) **The expanded use of coil tubing in both completion and workover operations.** Lohuis, G.; Lancaster, G.; Redmond, S. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Coil tubing has been utilized in Canada for well servicing since 1965. Initial use was limited to routine service such as well cleanouts, gaslifts, and small acid treatments. This was due to limitation in equipment component strength, tubing size, and tubing tensile strength. Over the past several years coil tubing services for more unconventional applications have been developed. In Prudhoe Bay, Alaska, coil tubing units are used as an alternative to service rigs. Coil tubing has increased in size from the original 19.05 mm, to both 31.75 mm and 38.1 mm. Increased equipment strength has allowed the servicing of deeper, higher pressure wells, and the design of a variety of specialized down hole tools specifically for coil tubing. These improvements have allowed coil tubing to be used for such services as squeeze and plug back cementing, drilling, wireline work, fishing and selective acidizing. Coil tubing is especially applicable in deviated wells, where conventional wireline technology is no longer viable. Case studies are presented to illustrate coil tubing applications in cement squeezes selective acidizing, and pipeline cleaning. 5 refs., 9 figs., 1 tab.

50426 (CIM/PS–CE03174, pp. 50.1-50.13, Paper 88-39-50) **The effect of acid (HCl) on the permeability of selected cardium formation sandstones and conglomerates.** Griffith, L.A. (Amerada Minerals Corp. of Canada (Canada)); Nelson, M.R. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The effects of HCl acid on sandstone reservoir permeability were investigated in a laboratory study on Cardium Formation samples. Results from this study show a variety of responses ranging from large improvements in liquid permeability to destruction of good reservoir rock. Critical variables in the type of response include lithology and diagenesis. In almost all samples, acid destabilized the fines. Fines migration caused mixed results in this study because fines can be flushed through the plug, enhancing permeability. Under reservoir conditions, the effects on permeability

would be more unanimously detrimental. In addition, limited evidence for the formation of permeability damaging iron hydroxide precipitates has been observed. 2 refs., 7 figs., 2 tabs.

50427 (CIM/PS–CE03174, pp. 54.1-54.15, Paper 88-39-54) **Interpretation of pressure buildup tests using afterflow data: Applicaton for pumping wells.** Strashok, G. (Core Labs. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Pressure buildup tests on pumping wells usually have significant afterflow following surface shut in. The measurement and use of this afterflow data has been the subject of much interest, as its application can lead to an earlier detection of a semi-log straight line, a more accurate description of the reservoir model, and confirmation of other analysis techniques. It is demonstrated that using indirect measurements of afterflow and bottomhole pressures (via acoustic methods), convolution and variable-rate superposition analysis concepts can be applied to buildup analysis for unfractured pumping oil wells. Consideration must be made for dead storage volume below the point of measurement and for changing wellbore storage coefficients. As these methods use total reservoir flow rates and volumes, presure-dependant parameters such as the gas formation volume factor and total reservoir compressiblity must be considered. For a pumping well, total reservoir voidage at the initial shut-in pressure gave practical results. Rate-normalization can help diagnose fractured well pressure buildup behaviour. 11 refs., 14 figs., 5 tabs.

50428 (CIM/PS–CE03174, pp. 55.1-55.8, Paper 88-39-55) **A simple approach for estimating average reservoir pressure in depletion-type reservoirs.** Al-Attar, H.H. (Univ. of Baghdad (Iraq)); Abdul-Majeed, G.H. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A simple approach is presented for estimating average reservoir pressure in solution gas drive reservoirs using data of two flow tests. The two general inflow performance relationship equations developed by Couto (1982) are the basis of this work. With this approach, and provided that certain data is available, the estimated flow efficiency, skin factor, and relative permeability to oil can be estimated. The present approach has many advantages over the previously published methods for estimating the above parameters. No estimates of reservoir properties are required and no buildup tests need to be run. Excellent agreement is shown between the estimated and actual results. A field example is solved to illustrate the use of the procedure presented. 8 ref., 1 fig., 2 tabs.

50429 (CIM/PS–CE03174, pp. 56.1-56.22, Paper 88-39-56) **The use of pressure build-up data in pressure transient testing.** Foster, G. (Gulf Canada Resources Ltd. (Canada)); Wong, D.; Asgarpour, S. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A unified approach is presented for incorporating today's increasingly sophisticated pressure analysis techniques into practical methods of well test analysis. The approach is based on the logarithm of pressure vs logarithm of time, commonly known as the log-log plot. Because its axes are of fixed dimensions relative to each other, a standard frame of reference is provided by which all tests may be compared regardless of pressure behavior. This facilitates quick qualitative assessment of the test through repeated pattern recognition criteria developed through experience. The conventional plots (of a pressure function vs time functions) can use data delineated by observing the pressure derivative response on the log-log plot to verify the well test interpretation. The strength of this unified approach is that the problems encountered in either type curve matching or conventional techniques are eliminated when both methods are used together. Matching the log-log of the test data against the appropriate theoretical model will provide quantitative reservoir information. However, this technique relies on selecting the correct model. Type curves for 3 theoretical reservoir models are discussed: an infinite acting homogeneous reservoir with wellbore storage and skin; finite conductivity fracture in an infinitely acting reservoir; and a finite linear reservoir. The use of conventional or straight-line methods is also described, as well as methods to correct buildup data and the use of gas pseudo pressure for analyzing fluid flow. 22 refs., 14 figs.

50430 (CIM/PS–CE03174, pp. 57.1-57.19, Paper 88-39-57) **Rationale for low injection rates and pressure cycles for firefloods in heavy oil reservoirs.** Tsang, P.W. (Husky Oil Operations Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A reservoir flow path model with low injection rates has been used to develop an alternate approach to firefloods in heavy oil reservoirs with initial oil mobility. Low injection rates are used to maintain and propagate the firefront in the reservoir. The pressures in the burn volume and the flow path are maintained lower than that in the unaffected reservoir, allowing oil from the unaffected reservoir to drain into the flow path and increase production. The fireflood process also generates upgraded oil with lower viscosities to further enhance oil mobility in the flow path. Pressure cycles can be used to facilitate additional oil re-saturation of the flow path to alleviate severe gas channelling ahead of the burn front. Injection and producing well casing pressure histories and fluid analysis data from the Husky Tangleflags Fireflood Project in Saskatchewan are reviewed to illustrate the beneficial effects of low injection rates and pressure cycles. 13 refs., 15 figs.

50431 (CIM/PS–CE03174, pp. 60.1-60.18, Paper 88-39-60) **In situ combustion experimental studies using a combustion tube system with stressed core capability.** Sibbald, L. (Univ. of Calgary, AB (Canada)); Moore, R.G.; Bennion, D.W.; Chmilar, B.J.; Ursenbach, M.G. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The in-situ combustion process for the recovery of crude petroleum from underground reservoirs is highly complex. Even on an elemental scale, its analysis requires physical simulation of realistic reservoir conditions in order to expose its characteristic, but system-specific, physical and chemical reaction mechanism relationships. In the continuing effort to develop experimental systems for the elemental physical simulation of the combustion process, a new combustion tube system was designed, constructed and successfully tested. The system incorporates a novel combination of: an unconsolidated or consolidated core material use capability; the ability to employ high net external pressures while using a thin wall combustion tube; and the use of a modular design with respect to systems components. An experimental program undertaken with the newly developed apparatus included isothermal cracking and low temperature oxidation tests, and a series of six normal air in-situ combustion tests in the 4-8 megapascal pressure range using different crude oils, bitumens, and core materials. The study was mechanistic in nature, with the goal being to reveal the effects of specific experimental condition changes on the performance of combustion propagation. In addition to generating data from observed stable combustion processes (i.e. air and fuel requirements), the experimental program revealed that a lower porosity

consolidate Berea sandstone core element required a greater injected air flux to allow process self-sustenance compared to an otherwise equivalent higher porosity unconsolidated Berea material pack. 24 refs., 8 figs., 5 tabs.

50432 (CIM/PS–CE03174, pp. 63.1-63.20, Paper 88-39-63) **A simplified method to predict overall production performance.** Kelkar, B.G. (Univ. of Tulsa, OK (USA)); Perez, G. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A simple method is presented for predicting the overall production performance of oil and gas systems. The proposed method is based on a simple mathematical algorithm that provides fast and accurate means to estimate the possible production rate that a system will be able to sustain. In addition, the method has been designed to search and determine for an unstable production rate that might exist in the system. The proposed method has been applied to a complete production system. The system is represented by a computer model and is capable of considering the effect of several production components including: reservoir, perforations, gravel pack, tubing, subsurface safety valve, wellhead choke, surface pipeline, and separator. A gas lift system may also be included. The model utilizes several published correlations to evaluate the pressure losses across these components. Results from the model are compared and agree closely with several cases presented in the literature. Finally, practical applications of the model are presented. These include a sensitivity analysis and an evaluation of unstable conditions in a gas condensate system. 43 refs., 4 figs., 9 tabs.

50433 (CIM/PS–CE03174, pp. 65.1-65.37, Paper 88-39-65) **Advances in formation damage assessment and control strategies.** Amaefule, J.O. (Core Labs. (Canada)); Kersey, D.G.; Norman, D.K.; Shannon, P.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Formation damage has been recognized as a major contributor to anomalous production and/or abnormal decline in productivity or injectivity in most hydrocarbon reservoirs. Many potential pay zones have been misdiagnosed as nonproductive, and payout on investment has been delayed. The economic implications of formation damage are illustrated by a simplified model of reduced permeability around a wellbore. The origin of the formation damage problem is outlined in terms of fluid-fluid and fluid-rock interactions. The mechanisms of formation damage are then presented by means of a review of recent experimental findings from the literature. This review includes the mineralogical factors affecting formation damage, interaction of fluids with water- or acid-sensitive minerals, fines migration, and scaling. The techniques used to recognize formation damage are described, such as drill stem tests, resistivity logs, nodal systems analysis, and production logging. Techniques for evaluation and treatment of formation damage are then discussed, including x-ray studies, complete petrographic analysis, and core flow tests. Special attention is paid to evaluation of damage induced by drilling fluids, evaluation of fines migration, and evaluation of permeability damage induced by high drawdown. 84 refs., 27 figs., 4 tabs.

50434 (CIM/PS–CE03174, pp. 66.1-66.14, Paper 88-39-66) **PVT [pressure-volume-temperature] data generation reporting and general uses.** Bujnowicz, R. (Core Labs. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The laboratory procedures for measuring pressure-volume-temperature (PVT) data are discussed. Each of the five PVT tests performed on samples of reservoir fluid is identified and the corresponding report explained. These tests include generation of data on pressure-volume relations, differential vaporization, viscosity measurement, separator or flash tests, and compositional analysis. The 2 most commonly used types of data, formation volume factor and solution gas-oil ratio, are generally not usable in their original forms for typical reservoir applications. The reasons for this are explained and techniques for adjustment of these data are presented. The application of PVT data is illustrated by 2 case studies. The first, a reservoir material balance study, shows which PVT data to use in the material balance equations. The second shows how PVT data in the form of flash testing may predict optimum separator operating conditions. 2 refs., 6 tabs.

50435 (CIM/PS–CE03174, pp. 67.1-67.27, Paper 88-39-67) **In-situ stress magnitudes from mini-frac records in Western Canada.** Woodland, D.C. (Shell Canada Ltd. (Canada)); Bell, J.S. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Instantaneous shut-in pressures and closure stresses are listed, derived from the records of 115 mini-frac tests run in Western Canada in recent years. One hundred and eight of the mini-fracs were run in Alberta wells and this data set is reviewed briefly. The measurements were made largely in reservoir sandstones, some of which exhibited formation pressures that had been lowered by recent production of hydrocarbons. There is considerable variability in the measured magnitudes of the smaller horizontal principal stress, S_{Hmin}, both locally and regionally, although the average gradient is similar to that of the Gulf Coast. Many S_{Hmin} magnitudes are low enough to suggest that vertical stress (S_V) $\geq$ maximum horizontal stress (S_{Hmax}) $\geq S_{Hmin}$ over much of the Alberta Plains. Higher S_{Hmin} values were obtained from wells within or near the foothills, pointing to a regime where $S_{Hmax} \geq S_V \geq S_{Hmin}$, but these mini-fracs were largely from deeper tests than those run beneath the plains. Hence, it is not proven whether S_{Hmin} actually increases towards the mountains or whether there is only a change in gradient with depth. 36 refs., 8 figs., 2 tabs.

50436 (CIM/PS–CE03174, pp. 68.1-68.16, paper 88-39-68) **Fracturing pressure analysis applied to heterogeneous formations.** Dusterhoft, R.G. (Halliburton Services Ltd. (Canada)); Kreuger, S.B.; Sims, M.R. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

There are many areas in western Canada that have shown abnormal pressure responses during hydraulic fracturing which make treatment design and proppant placement very difficult. These unpredicted responses are thought to be due to heterogeneous formation characteristics such as natural fractures, faults, high permeability streaks and abnormal stresses. The application of computerized data collection and analysis during hydraulic fracturing has made it possible to closely examine many treatments in these areas. It was found that the presence of heterogeneous formation conditions can be identified using treating pressure analysis following specialized minifrac techniques. By examining the pressure response, it is possible to make specific design modifications that improve proppant placement in such abnormal well conditions. Some general design guidelines are presented for treating heterogeneous formations. Case histories of successful applications in Alberta are included. 11 refs., 9 figs.

50437 (CIM/PS–CE03174, pp. 69.1-69.14, Paper 88-39-69) **Interwell communication by concurrent fracturing: A new well stimulation technique.** Moschovidis, Z.A. (Amoco Production Co. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A new fracturing technique is proposed, referred to as concurrent fracturing, to effect communication between two or more adjacent wellbores. As the name implies, two or more wells can be fractured concurrently to enhance the chances that the created fractures interconnect. The technique can be applied primarily for horizontal fractures. It can also be applied for vertical fractures provided that the wells are spotted roughly in the direction of fracture azimuth. The rationale for the potential success of such a fracturing technique is based on the following argument. When two fractures are in relatively close proximity and propagate towards each other, the induced tensile stress fields ahead of the tips reduce the effect of the closure stress and cause the fractures to interconnect. The treating pressure of each well is expected to drop concurrently when the fractures interconnect and afterwards to stabilize to a lower level. This simultaneous pressure drop depends on the sizes of the fractures when they interconnect and can be used to detect fracture communication. Some motivation for concurrent fracturing is given as well as the theoretical basis for its potential effectiveness. Two examples of well treating pressure monitoring scenarios are also presented. 5 refs., 10 figs., 4 tabs.

50438 (CIM/PS–CE03174, pp. 71.1-71.20, Paper 88-39-71) **Effective hydraulic stimulation of the Lower Amaranth Formation in southern Manitoba.** Kooyman, R.W. (Home Oil Ltd. (Canada)); Muir, M.B.; Marcinew, R.P.; BenNaceur, K. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Spearfish, or more properly Lower Amaranth Formation in southwest Manitoba is a low permeablity sandstone reservoir containing light oil. Wells drilled into this formation are generally not capable of commercial production until after a hydraulic fracturing stimulation. Factors such as an underlying water zone, along with an unconfined producing interval, have resulted in numerous hydraulically fractured Lower Amaranth wells producing water rather than oil, limiting potential field development. Following the unsuccessful stimulation of several wells in the South Pierson field where hydraulic fractures propagated into the underlying water zone, a comprehensive re-evaluation and detailed design effort was implemented to minimize the potential for water production. The project incorporated geological studies; reservoir rock elastic properties determination and correlation with wireline logging techniques; determination of horizontal in situ stresses; reservoir performance testing; in situ fracture fluid performance evaluations; and 2- and 3-dimensional fracture geometry modelling techniques. It has resulted in new treatment designs incorporating fracture diversion and net pressure control techniques. This paper discusses the general stratigraphy of the Lower Amaranth zone and the completion requirements. The design concepts, data analyses and results of a number of Lower Amaranth formation stimulations are presented. Optimal treatment considerations and guidelines are provided to minimize the probability of water production following hydraulic fracture stimulation. 17 refs., 9 figs.

50439 (CIM/PS–CE03175, pp. 100.1-100.22, Paper 88-39-100) **Evaluation of solvent and chase gas bank sizes in the South Swan Hills hydrocarbon miscible flood.** Sorensen, L.E. (Total Petroleum Canada Ltd. (Canada)); Griffith, J.D. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A secondary hydrocarbon miscible flood was initiated in an area of the South Swan Hills Unit (Alberta) in 1973. The 15 years of performance, encompassing both solvent and chase gas injection, has provided an extensive basis for performing a history-matched simulation study. The problem of evaluating and optimizing the volumes of solvent and chase gas used in a field scale hydrocarbon miscible flood has been analyzed with a three-dimensional, fully compositional simulator wherein physical dispersion effects and the development and loss of miscibility were investigated. The analysis resulted in valuable information on the conditions required for simulation of the slug process and on sizing of the banks as well as the effects of other operational parameters. It was found that 12 grid blocks between wells are required to obtain a reasonable description of the miscible slug process. Oil recovery of 58% and solvent recovery of 68% is predicted with 30% hydrocarbon pore volume chase gas. Ultimate recovery is indicated to be unaffected by gas-water ratios between 0.33 and 1.00, allowing individual gas-water ratios to be tailored to meet gas handling schedules and to reduce gas breakthrough. Reducing the cycle size to 0.5% hydrocarbon pore volume is indicated to dampen the cyclic nature of gas production. Increasing the solvent portion of the hydrocarbon slug increases the level of oil recovery. 7 refs., 13 figs., 3 tabs.

50440 (CIM/PS–CE03175, pp. 101.1-101.4, Paper 88-39-101) **A scaling criterion for miscible displacements.** Coskuner, G. (Petroleum Recovery Inst. (Canada)); Bentsen, R.G. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

One of the most effective methods to evaluate the merit of a miscible oil recovery process is that of using scaled laboratory models to simulate reservoir conditions. In this regard, it is important to keep in mind that, because the solvent used is typically less viscous than the oil diplaced, most miscible displacements are dominated by viscous fingering. Because viscous fingering largely controls the breakthrough recovery, and consequently the economic return to be expected from miscible displacements, it is important that such fingering be properly accounted for. However, conventional scaling methods cannot properly account for the viscous instabilities usually associated with miscible displacements. A recently developed scaling group is presented which can be used for the purpose of scaling instability in the laboratory. The new scaling group arises out of a cut-off wavelength criterion. Moreover, it includes explicitly, for the first time, the effect that the length of a porous medium has on the instability of a miscible displacement. In addition, it is suggested that the value of the scaling group for the model should be made as close as possible to that in the prototype, in order that the flow regime be properly scaled. If the conditions of similarity for both dispersion and geometry are to be met, conventional scaling techniques lead to impractically large laboratory models. Consequently, it is usual to relax the scaling requirement on dispersion. Although the individual effect of transverse and longitudinal dispersion cannot be scaled, their combined effect on the controlling mechanism for most miscible displacements (viscous fingering) can be scaled using the new scaling criterion. 27 refs.

50441 (CIM/PS–CE03175, pp. 103.1-103.23, Paper 89-39-103) **Economics of air separation products used for both enhanced hydrocarbon and sulphur recovery.** Hvizdos, L.J. (Air Products and Chemical Inc. (Canada)); Masetti, A.W.; Metzler, K.J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum

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The concept of using the nitrogen from an air separation plant for enhanced hydrocarbon recovery and the oxygen for sulphur production is reviewed. An area within Alberta is identified where the potential exists for using both nitrogen and oxygen from an air separation plant. For oxygen-based sulphur recovery, both the classic oxygen enrichment process and the COPE™ process are reviewed. The limitations of the classic oxygen enrichment process to achieve high levels of oxygen enrichment for rich acid gas feeds are described. It is shown how the COPE process overcomes these limitations by its ability to control the furnace temperature at high oxygen enrichment levels and rich acid gas feed concentrations. Nitrogen injection and rejection costs are presented for the case in which nitrogen is the primary economic driving force for a project to recover hydrocarbons. For this case, the economic benefits of using the oxygen vent in existing or grass roots sulphur recovery plants are demonstrated. 28 refs., 11 figs., 4 tabs.

50442 (CIM/PS–CE03175, pp. 104.1-104.9, Paper 88-39-104) **Cementing across massive salt formations.** Yearwood, J. (Dowell Schlumberger Inc. (Canada)); Drecq, P.; Rae, P. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Historically the cement slurries used on primary cementing jobs performed across massive salt and evaporite sequences have always had some technical limitations. These limitations result in poor initial cement compressive strength, which leads to casing collapse due to well encroachment from the highly plastic formations, and also to poor zonal isolation because of bad cement/formation bonding. A new salt-rich cement slurry with controlled properties for cementing and isolating these difficult formations has been designed and applied in the field. Apart from precise thickening times, these slurries also exhibit excellent fluid loss control and very low rheological parameters. This latter property allows convenient turbulent flow placement in even relatively large annulus configurations. A laboratory study was made in order to determine the optimum salinity of the starting slurry so that any salt dissolution downhole will not have any detrimental effects on the slurry properties. Long term studies are also shown in order to demonstrate that these slurries provide excellent protection from aggressive brines which are often associated with the salt/evaporite formations. Normal cement systems do not withstand this degradation caused by brine contact, especially that from magnesium. This extra strength protection reduces the risk of long term casing corrosion and collapse. Field case studies from the Williston Basin and the Middle East are described and compared to the prior art. 9 refs., 5 figs., 4 tabs.

50443 (CIM/PS–CE03175, pp. 105.1-105.7, Paper 88-39-105) **A new technique for solving lost circulation problems and zone plugging.** Yearwood, J. (Dowell Schlumberger Inc. (Canada)); Boissier, J.C.; Vidick, B. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

During drilling or cementing, lost circulation may be encountered due to the presence of highly permeable formations, which may result from a high natural permeability in a sandstone, or large natural fractures and vugs as found in limestones. This problem is critical as it increases the drilling costs. Cement plugs can be used but their placement and the time necessary to drill through them make their use relatively costly. The use of an internally activated silicate solution allows one to obtain a solid free Newtonian solution with a very low initial viscosity. After a given period of time, which depends on the fluid design and the temperature, the viscosity of the solution increases rapidly to form a gel. This gel is coherent, strong, and does not develop free water as a function of time. The very low initial viscosity of this solid free fluid allows it to be pumped directly through the bottom hole drilling assembly, therefore saving time, and provides deep penetration of the final gel. A high pressure experimental set up was used to plug various cores of different permeabilities and with different saturation fluids. Results are presented on the extrusion resistance obtained after one hour and after one week. This gel is shown to withstand differential pressures greater than 1500 psi per foot of plugged formation. Some results on the long term stability of this gel to aggressive brines, organic compounds and oil are included. Case studies of jobs performed in Europe and the Middle East are also presented. 4 refs., 3 figs., 2 tabs.

50444 (CIM/PS–CE03175, pp. 107.1-107.8, Paper 88-39-107) **Rheology of drilling fluids in deep wells: Measurements and evaluation.** Moussa, M.M. (Univ. of Calgary, AB (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Most of the drilling fluid currently used for deep and super deep drilling are very complex in nature and chemistry due to severe conditions encountered at these depths. The mud, while circulated in the hole, experiences a gradual increase in temperature and exponential increase in shear rate. These factors substantially alter the rheological properties if the fluid composition is not properly formulated and instantaneously conditioned. An experimental set-up has been developed to measure and monitor the dynamic behaviour of the fluid rheology. The equipment simulates the drill string and the drilled hole parameters such as pressure, temperature of the penetrated formation, circulation rate, and the shear rates. Pressure drop and the flow rates data measured across the pipe viscometer are used to profile the flow diagrams and consistency curves of each batch. A series of data is obtained for power law constants, consistency factor, non-Newtonian behaviour index (n), and effective viscosity as a function of temperature and shear rate for two fluids. Extreme value of shear rate was 12,000 sec^{-1} and temperature was 425°F. The effective viscosity is reduced to a minimum as shear rate increased to maximum. Because of this, n values increased to reach a value of one, which describes a Newtonian fluid behaviour instead of non-Newtonian at the beginning of the test period. More than that, the n value changes, in fact pointing out that under the effect of the wide range of shear rates existing in the hole, the mud rheological behaviour could become pseudo plastic, Newtonian and dilatent, depending on the value of n. 5 refs., 7 figs.

50445 (CIM/PS–CE03175, pp. 99.1-99.10, Paper 88-39-99) **New scaling criteria for chemical flooding experiments.** Rafiqul Islam, M. (Petroleum Recovery Inst. (Canada)); Farouq Ali, S.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Numerous studies dealing with chemical flooding experiments have been reported. However, these have been performed in unscaled models, due to lack of scaling criteria. A new mathematical formulation provides a complete representation of cosurfactant-enhanced alkaline/polymer processes. Unlike previous approaches, the proposed model accounts for transient interfacial tension (IFT) and nonequilibrium mass transfer phenomena. Experiments suggest that, at ultralow IFT values, oil recoveries become sensitive to transient IFT values. The presence of polymer slightly modifies the nature of dynamic IFT behaviour. The proposed model also incorporates polymer and surfactant adsorption. In addition, chemical reactions and convective mass transfer along with diffusion and dispersion are accounted for. The governing partial differential equations are used to derive a new set of scaling criteria, which

are also derived using dimensional analysis. The latter was particularly useful for processes for which a differential or parametric equation was not available. A variety of scaling options are investigated and their relative merit pointed out. Situations are presented where, by relaxing the requirement of geometric similarity, the same fluid and the same porous medium can be used. It is shown that for most situations the mass transfer rates have to be different in the model and the prototype. This finding contradicts common experimental practice in which the mass transfer rate is assumed to be the same as in the field. The conditions for properly scaling adsorption and all pressure-dependent properties along with dispersion are indicated. Criteria are recommended for selecting the scaling group best suited for specific applications. 12 refs.

50446 (DOE/BC/14126–27) **Characterization of surfactants as steamflood additives.** Hamida, F.M.; Demiral, B.M.R.; Castanier, L.M.; Brigham, W.E. Stanford Univ., CA (USA). Petroleum Research Inst. Sep 1990. 61p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87BC14126. (SUPRI-TR–79). Order Number DE90000263. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Steamflood efficiency can be increased by adding surface active agents to steam such that foam can be generated, can preferentially reduce permeability to steam in previously swept zones, and can divert the steam to undepleted regions of the reservoir. In this study, a linear model was used to compare and characterize eight surfactants as steamflood additives under typical California conditions of moderate temperature and pressure. The evaluation of foamability was based on pressure gradient changes and steam mobility reduction along the model. Two sets of experiments were made. In the first, no oil was present in the sandpack. In the second, West Newport crude oil was used at residual saturation after steam flooding. All runs were performed under the same operating conditions! Results from the first set of runs indicated that alpha olefin sulfonates generated the strongest foam. Flow resistance due to foam increased as the alkyl chain length increased. Enrichment in disulfonate content enhanced the propagation speed of an alpha olefin sulfonate but reduced its foam strength. Significant steam mobility reduction was achieved for all surfactants tested. Relative permeability to steam was reduced to between 0.005 and 0.02 when no oil was present. Analysis of temperature and pressure profiles indicated the formation of a nitrogen foam ahead of a steam foam. 41 refs., 36 figs.

50447 (DOE/BC/14126–28) **SUPRI [Stanford University Petroleum Research Institute] heavy oil research program: Final report, February 22, 1987–February 21, 1990.** Brigham, W.E.; Ramey, H.J. Jr.; Aziz, K.; Castanier, L. Stanford Univ., CA (USA). Petroleum Research Inst. [1990]. 30p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87BC14126. Order Number DE91000574. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is a summary of the work performed under Department of Energy contract FG19-87BC14126 during the period February 22, 1987 to February 21, 1990. During that period the Stanford University Petroleum Research Institute has published twenty-two technical reports and professional papers. This report presents in general terms the scope of work of SUPRI which is divided in five main projects: reservoir properties, in-situ combustion, improvement of steam injection by additives, well-to-well formation evaluation, and field support services. The results obtained during the period of performance of the contract are then presented in the form of abstracts from the technical reports and papers written during the period of performance.

50448 (DOE/BC/14449–2) **A study of surfactant-assisted waterflooding: Final report.** Scamehorn, J.F.; Harwell, J.H. Oklahoma Univ., Norman, OK (USA). Sep 1990. 45p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14449. Order Number DE90000261. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

In surfactant-assisted waterflooding, a surfactant slug is injected into a reservoir, followed by a brine spacer, followed by second surfactant slug. The charge on the surfactant in the first slug has opposite sign to that in the second slug. When the two slugs mix in the reservoir, a precipitate or coacervate is formed which plugs the permeable region of the reservoir. Subsequently injected water or brine is forced through the low permeability region of the reservoir, increasing sweep efficiency of the waterflood, compared to a waterflood not using surfactants. In this part of the work, two major tasks are performed. First, core floods are performed with oil present to demonstrate the improvement in incremental oil production, as well as permeability modification. Second, a reservoir simulation model will be proposed to further delineate the optimum strategy for implementation of the surfactant-assisted waterflooding, as well as indicate the reservoir types for which it would be most effective. Surfactants utilized were sodium dodecyl sulfate and dodecyl pyridinium chloride. 44 refs., 17 figs., 3 tabs.

50449 (DOE/CE/15345–T4) **[Develop operating prototype ultrasonic system by updating engineering prototype]: Final report.** Tubesonics International, Inc., Norman, OK (USA). 2 Mar 1990. 2p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-87CE15345. Order Number DE90017620. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

TubeSonics International Inc., was awarded a grant through the ERIP program to up-grade the technology of ultrasonic inspection equipment. The equipment to be developed was to use existing patents belonging to the principal investigator W. A.(Ben) Livingston. The equipment to be developed was to be used primarily in the inspection of the oil country tubular goods (OCTG) generally associated with both the exploration and production of fossil energy from a well bore. Products such as casing, tubing and drilling pipe are normally included in this category. The grant contemplated the completion of eight(8), major work statements. Included in these work statements were the challenge of developing a computer controlled inspection that provided real time digital data collection, evaluation and real time reporting of the engineering data. All parts of the eight(8) work statements have been completed and properly tested as of February 26, 1990. The commercial operating system will be in service on March 14, 1990. This documents discussed the details of the work statement.

50450 (DOE/SF/00098–T16) **A dual-gas tracer technique for determining trapped gas saturation during steady foam flow in porous media.** Gillis, J.V.; Radke, C.J. California Univ., Berkeley, CA (USA). Dept. of Chemical Engineering. Sep 1990. 32p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC03-76SF00098. Order Number DE90000260. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Foam is a possible mobility control agent for effective oil displacement from reservoirs. Micromodel studies and prior gas-phase tracer experiments show that a significant fraction of the gas in a foam exists as trapped bubbles which, therefore, have a major impact on the flow resistance. To obtain quantitative measurements of trapped gas saturations, we have developed a unique experimental apparatus employing dual gas tracers. During steady foam flow in a porous medium, dilute sulfur hexafluoride (SF_6) and methane (CH_4) tracers in a nitrogen carrier are injected, and the effluent concentration is monitored by gas chromatography. The measured tracer histories are fit to a simple mass transfer model which describes any partitioning between the mobil and trapped foam phases. Tracer effluent concentrations predicted by the model are strongly influenced by the solubility of each tracer in the liquid phase. Hence, multiple gas tracers provide a discriminating assessment of trapped gas saturation during foam flow through porous media. New trapped gas saturations are reported for an aqueous C_{14-16} α-olefin sulfonate foamer solution and nitrogen flowing through a 2.3-μm^2 fired Berea sandstone at 10^5 Pa (1 atm) back pressure and at room temperature. 26 refs., 7 figs., 1 tab.

50451 Dual leakoff behavior in hydraulic fracturing of tight, lenticular gas sands. Warpinski, N.R. (Sandia National Laboratories, Albuquerque, NM (US)). *SPE (Society of Petroleum Engineers) Production Engineering (USA),* 5(3): 243-252 (Aug 1990). DOE Contract AC04-76DP00789.

Stimulation experiments conducted in anisotropic, naturally fractured, tight, lenticular gas sandstones have shown the existence of a dual-leakoff phenomenon. Below a threshold pressure, the leakoff coefficient is very low and fluids are very efficient. Above the threshold, leakoff increased by a factor of 50, slurries dehydrate rapidly, and screenouts occur in minutes. The leakoff has

been shown to be controllable to some extent with 100-mesh sand. Results of three stimulation experiments are presented, including a treatment that screened out, a minifracture experiment that showed the effectiveness of 100-mesh sand, and a final successful stimulation.

50452 Composition paths in four-component systems: Effect of dissolved methane on 1D COsub 2 flood performance. Monroe, W. (Stanford Univ., CA (USA)); Orr, F. Jr.; Silva, M.; Larson, L.L. *SPE (Society of Petroleum Engineers) Reservoir Engineering (USA),* 5(3): 423-431 (Aug 1990).

New measurements of phase compositions and densities are reported for a quaternary system containing CO_2, methane, butane, and decane and related ternary systems at 160°F and 1,250 psia [71°C and 8620 kPa]. Measured values of phase compositions and vapor densities agreed well with values calculated with the Peng-Robinson equation of state (PREOS), through calculated liquid densities were less accurate. Composition paths for two-phase flow of four-component mixtures were calculated with the method of characteristics and the equation-of-state (EOS) representation of the phase behavior. Analysis of resulting paths indicates why displacement efficiency in 1D CO_2 floods is insensitive to the addition of dissolved methane to the oil displaced.

0204 Processing

Refer also to citation(s) 50265, 50266, 50267, 50270, 50272, 50297

50453 (CONF-9008140–2) **A critical review of organic fluid fouling.** Watkinson, A.P. (British Columbia Univ., Vancouver, BC (Canada). Dept. of Chemical Engineering); Panchal, C.B. Argonne National Lab., IL (USA). Jul 1990. 27p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From AIChE summer meeting; San Diego, CA (USA); 19-22 Aug 1990. Order Number DE90017683. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A critical review carried out to determine the present status of understanding of organic fluid fouling is discussed. In addition, a technical approach is presented for the development of mechanism-based analysis that includes the chemical and physical processes associated with organic-fluid fouling. Analysis of the literature data indicate that organic-fluid fouling usually involves a two-step process in which soluble precursors are first formed followed by a second step in which insoluble foulant is produced. The quantitative effects of physical parameters such as fluid temperature, heat flux and velocity on the rate of fouling are poorly understood. The proposed analytical approach is based on three cases developed on the basis of location of reaction zones where the foulant formation occurs. The objective of the analytical approach is to characterize the effects of physical parameters and to determine the threshold conditions. 51 refs., 2 figs., 9 tabs.

50454 Catalytic functionalities of supported sulfides V. C-N bond hydrogenolysis selectivity as a function of promoter type. Shabtai, J. (Univ. of Utah, Salt Lake City (USA)); Balusami, K.; Nag, N.K.; Massoth, F.E.; Guohe, Que. *Journal of Catalysis (USA),* 113(1): 206-219 (Sep 1988).

Two types of γ-Al_2O_3-supported catalyst were prepared and their selectivities for C-N bond hydrogenolysis determined. These were (a) sulfided MMo catalysts (where M = Fe, Co, Ni, Ru, Rh, Pd, Ir, Pt, Re, or Cr), containing 25 mmol M and 77 mmol Mo/100 g Al_2O_3; and (b) sulfided M catalysts, without Mo, containing 25 mmol M/100 g Al_2O_3. Pseudo-first-order rate constants for C-N bond hydrogenolysis of indole (k_1) and ring hydrogenation of naphthalene (k_2) were determined (at 350°C and 137 atm H_2 pressure) for the above catalysts as a function of the periodic table position of M. It was found that the C-N hydrogenolysis vs ring hydrogenation selectivity of the MMo catalysts, as expressed by the k_1/k_2 ratio, was in the order RuMo > IrMo > CrMo > PtMo > CoMo > FeMo > NiMo > ReMo > RhMo > PdMo. RhMo, NiMo, and CoMo show highest C-N hydrogenolysis activity, but relatively low selectivity due to their high ring hydrogenation activity. The sulfided M catalysts, except Pt and Pd, showed markedly lower C-N hydrogenolysis activities than the corresponding MMo catalysts. Comparison of the actual C-N hydrogenolysis activities of MMo catalysts with their additive activities shows that Ni, Rh, Co, Fe, and Ru strongly promote, whereas Pt and Pd strongly depress the C-N hydrogenolysis activity of the corresponding MMo catalysts. Similar promoting (or depressing) effects of the M components are also observed in comparing the actual and additive ring hydrogenation activities of the MMo catalysts. The high C-N hydrogenolysis selectivity of RuMo, IrMo, and PtMo points to the possible use as improved catalysts in HDN of heavy oils, involving lower hydrogen consumption than that found with conventional Ni- and Co-promoted catalysts. 27 refs.

50455 A study of the activity and selectivity of molybdenum crystallographic shear compounds in the oxidation of C_4 hydrocarbons. McCormick, R.L. (Dept. of Energy, Ames, IA (USA)); Schrader, G.L. *Journal of Catalysis (USA),* 113(2): 529-534 (Oct 1988). DOE Contract W-7405-ENG-82.

Oxides which are catalysts in the selective oxidation of olefins are thought to form crystallographic shear (CS) structures. These structures can form as a result of the removal of lattice oxygen which leads to a change from corner to edge sharing of some of the metal-oxygen octahedra. Oxygen removal also results in reduction of some of the metal atoms to form a mixed valence solid. This work was undertaken with the goal of illuminating the role of these reduced molybdenum-oxygen structures in selective oxidation. In particular, several molybdenum CS compounds were studied and compared with MoO_3.

0206 Health and Safety

Refer also to citation(s) 50679, 51881

50456 (CPA–90-04408) **A report on enhancements for existing and future helicopters supporting operations of the Canadian oil and gas industry.** Canadian Petroleum Association, Calgary, AB (Canada). 15 Jul 1989. 190p. (MICROLOG–90-04408). Source: PC Canadian Petroleum Association, 3800 - 150 6th. Ave. S.W., Calgary, AB, CAN T2P 3Y7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

A study was conducted to investigate and determine those enhancements that pertain to the safe operation of helicopters in support of oil exploration and production. A review of the problems related to helicopter accidents examines the human tolerance limits in helicopter accident situations and some of the environmental hazards. Seven safety enhancement topics are then considered. These topics include structures, seats, restraints harness, fuel and fuel systems, overwater operational systems, powerline wire warning devices and flight data recorders. Under each topic, information is provided on related accidents; developments and research; industry, academic and regulatory recommendations; conclusions on safety effectiveness; and equipment availability. An attempt is made to identify practical areas for safety enhancement. It is suggested that shoulder restraint harnesses and crashworthy fuel systems are practical safety enhancements with minimal weight and cost penalties. For overwater operations, externally mounted automatic deployed liferaft systems, retrofitting helicopter floatation bags with scoops and new developments in aviation liferafts should be considered for enhancing overwater flight safety. Energy absorbing devices are possible enhancements for new helicopter acquisitions and wire warning devices should be considered in certain operations. In addition, flight data recorders can be considered to enhance flight safety, and accident prevention programs and are likely to become required in helicopters in the future. An appendix to this study contains promotional information on safety enhancement systems collected from manufacturers and suppliers. 16 refs., 17 figs., 3 tabs.

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50394, 50395

50457 (CIM/PS–CE03173, pp. 33.1-33.9, Paper 88-39-33) **China: Oil and gas pandamonium.** Wong, J.F (Novacorp International Consulting Ltd. (Canada)). Petroleum Society of CIM

(Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Plans to triple China's oil production rate to 6 million bbl/d by year 2000 and triple gas production to 3.7 billion ft^3/d in the next five years clearly indicates an oil boom, with consequent opportunities for Canadian companies. Use of Canadian technology, equipment, personnel and expertise are steadily on the rise in China. Highlights are presented of some Canadian companies who have won projects in China through hard work, innovative selling, tough negotiating, persistence and patience. These include Teknica Resource Development, who has completed over 30 exploration projects, utilizing innovative seismic data processing techniques and expertise in stratigraphic interpretation; Canadian Foremost, who introduced a tracked vehicle for oilfield applications which was specially designed for Chinese conditions; Nowsco Well Service, an oilfield equipment supplier; Willowglen Systems, who is to install an advanced control and data acquisition system for use in the Liaohe oilfield; Lavalin International, who provided engineering design and construction assistance to the Liaohe oil and gas production/processing/storage system; Lummus Canada, who supplied two petrochemical plants; and Nova Corporation, who is providing China with pipeline and heavy oil production technology. 2 figs.

50458 (CIM/PS–CE03173, pp. 37.1-37.18, Paper 88-39-37) **A statistical model to evaluate a hydrocarbon miscible flood in an Upper Devonian field in Central Alberta.** Asgarpour, S. (Gulf Canada Resources Ltd. (Canada)); Papst, W. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The estimation of profitability indicators for an enhanced oil recovery process depends on several parameters such as incremental oil recovery, production forecasts, price forecast, and capital and operating costs. However, for most of these parameters only a range may be available. A mathematical model based on the Monte Carlo technique is used to predict the profitability indicators of a hydrocarbon miscible flood in an Upper Devonian field in central Alberta. Based on a detailed geological study different reservoir types were identified in this field. A distribution of incremental oil was obtained from a wide range of geological and reservoir data. Simulation studies were performed to generate production forecasts for each reservoir type and to provide the data required for a Monte Carlo simulation study. Continuation for the Monte Carlo technique into the net present value analysis was also developed. Special consideration was given to test all variables for dependency. The proposed model predicts the profitability indicators of the hydrocarbon miscible flood, accounting for the technical, and ecomomic risks associated with the miscible flood and the uncertainty of the oil price. 3 refs., 11 figs., 3 tabs.

50459 (CIM/PS–CE03173, pp. 7.1-7.14, Paper 88-39-07) **Corporate finding and development costs, 1984-1986.** Grecu, J. (Canadian Oil Patch Analyst Inc. (Canada)); Ziff, P.H. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A comparison is made of the relative efficiency of 42 leading oil and gas producers in finding and developing new hydrocarbon reserves in western Canada over the 1984-1986 period. The approach of this study is empirical, using strictly actual reserve and cost data, with a focus on full-cycle economics (total replacement or on-stream cost) including both exploratory and development costs. A study of the finding cost in the stricter sense as used by explorationists is also presented as a sub-case. Only proven conventional reserves and changes within this category are considered. The aggregate finding and development cost results of $11.20 per barrel of oil equivalent (BOE) for the period studied were higher than expected. Although calculated on a before-tax basis, there seems to be a significant gap between that cost figure and the going concern value of typical western Canadian reserves. This is partly due to the high price expectations of producers prior to the 1986 price crash. Many companies were unable to replace their depleting reserves at cost levels which would assure a 12% after-tax return, which may explain the recent flurry of acquisition activity. Over the 3 years analyzed, the finding and development cost figures rose steadily, while the BOE replacement ratios dropped. The revisions recorded were very significant, influencing materially both the costs and reserve additions. Oil and gas reserves had opposite changes: while oil discoveries and extensions were dropping but revisions were strongly positive, gas discoveries rose and had substantial negative revisions. Significant variations were noted between the efficiencies of the 3 industry sectors (integrated, senior, and medium-to-junior producers). 9 figs.

50460 (CIM/PS–CE03174, pp. 74.1-74.21, Paper 88-39-74) **International market development through technical assistance: PCIAC's [Petro-Canada International Assistance Corporation] Thailand project.** Ridsdel, J. (Petro-Canada International Assistance Corp. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Thailand Technical Co-operation project of Petro-Canada International Assistance Corporation (PCIAC) is described and discussed as an example of one way to develop overseas markets for Canada's petroleum industry. The project represents a $4.7 million effort to provide high quality training and technical assistance to the Thai petroleum industry, while highlighting Canadian capabilities in the oil and gas sector. Over a 2-year period, 58 project components have been planned for implementation, addressing a wide variety of operations from project development and exploration through production and distribution. Some lessons learned from PCIAC's experience are presented. These include the long-term nature of the technical assistance process, the need for hands-on or people-intensive management in a situation where human factors are critical in determining success, the need to use staff with appropriate cross-cultural expertise, the requirements for cross-cultural communication, and flexibility in project design. The project has enabled introduction of Canadian petroleum companies into Thailand in a meaningful and useful manner, and has provided an opportunity to build significant relationships with senior management in the Thai petroleum sector. 4 figs.

50461 (CIM/PS–CE03174, pp. 75.1-75.12, Paper 88-39-75) **Project cash flow analysis: How to avoid the fast track to red ink.** Martin, V.N. (D and S Petroleum Consultants Ltd. (Canada)); Smith, B.J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A better understanding of the impact of cash flows on project costing and control is essential to effective proposal development and efficient project management in the petroleum industry. Analyses are provided of typical receipts and disbursements relating to international contracts to show how financial costs/benefits can affect project profitability. A structured approach to cash flow analysis is described which should be useful in costing and managing future international projects. An example is presented to illustrate the sensitivity of project financial costs to changes in the timing of receipts and disbursements, and to changes in costs and benefits related to cash balances. 4 figs.

50462 (CIM/PS–CE03174, pp. 77.1-77.11, Paper 88-39-77) **International trade implications for U.S.S.R. sulphur in the 1990's.** Wenzel, W.J.M. (INTCAN Economic Development and Finance Associates Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Major expansions in the processing capacity of natural gas and crude oil are bringing the USSR into the forefront as one of the largest producers of recovered elemental sulfur. Annual production capacity for elemental sulfur, oil and gas processing and mining in the USSR may be expanding from 5,740,000 tonnes/y in 1987 to almost 12,000,000 tonnes/y by the year 2000. The USSR is preparing to enter offshore export markets. A major sulfur prilling, storage and rail car loading facility is to be built at the large Astrakhan gas plant complex northwest of the Caspian Sea. Initial annual export capacity of 1 million tonnes can be expanded to 3 million tonnes at a later date. An offshore sulfur terminal is planned for a port near Odessa on the Black Sea. Tenders for prilling, storage and rail car loading facilities were submitted late in 1987. As of this date no commitments to commence construction have been made. Construction and commissioning is estimated to take 1.5 to 2.5 years. It is currently estimated that the USSR could participate in the world market with relatively modest volumes of sulfur by 1991 and increase its presence judiciously thereafter following a buildup of strategic inventories. In the longer term and about the year 2000, the USSR is likely to balance supply and consumption of sulfur in all forms at the 14 million tonnes level and net exports may be insignificant. The USSR is, in the foreseeable future, unlikely to become a major long-term exporter of sulfur. 7 tabs.

50463 (CIM/PS–CE03174, pp. 79.1-79.8, Paper 88-39-79) **Contracting for performance with employees.** Wichert, A. (Dome Petroleum Ltd. (Canada)); Lebedovich, B. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A results-oriented approach to improve profits in oil and gas operations has been developed which applies the principles of performance management in a large decentralized operation in Alberta. All supervisors and employees in the district participated in developing measurable improvement goals which individually were modest, but collectively achieved substantial production increases and cost savings. This paper describes the implementation strategy used, the changed roles of supervisors and employees, and the process which supervisors followed in negotiating with employees to contract measurable improvements. The barriers to implementation and the results achieved, are also discussed. 4 refs., 4 figs.

50464 (CIM/PS–CE03174, pp. 80.1-80.14, Paper 88-39-80) **An overview of bank security for the oil and gas professional.** Laffin, M.J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

An overview is presented of the various types of security that banks request from an oil or gas company before they advance money to that company. First, the type of debentures are defined and explained, and the situation of a borrower default under the terms of a debenture is described. Reference throughout is made to Canadian laws and practice. The advantages of fixed- and floating-charge debentures are outlined. Another type of security described is that available under Section 177 of the Bank Act, which is the primary type of security taken by banks for loans dealing with oil and gas properties in Canada. It is essentially a statutory fixed-charge security available only to Canadian chartered banks, and some problems and ambiguities with Secton 177 are reviewed. Finally, the securing of loans via assigning of receivables (including sales revenues, royalties, and government incentives) is discussed. It is noted that debenture security is not only the most advantageous security for banks, but may also be the preferred form of security for the borrower. 11 refs.

50465 (CIM/PS–CE03174, pp. 81.1-81.7, Paper 88-39-81) **Entrepreneurship: Creating the future.** Nichol, K. (K.R. Nichol Associates Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A new spirit of entrepreneurship has pervaded our society that will change our economic future. The entrepreneurial profile is examined, contrasts drawn with previous global circumstances, and statistics and examples are given to build a model for the future of the Canadian petrolem industry. Developing more automony, self reliance, innovation, risk taking and the ability to recognize and exploit opportunities are strongly advocated to meet the challenge of growth. 4 refs., 1 fig.

50466 (CIM/PS–CE03174, pp. 82.1-82.8, Paper 88-39-82) **Loss control: A business opportunity.** Robertson, M.R. (Petro-Canada Resources (Canada)); Gordon, S.K. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Loss control can be implemented as a routine part of the operation of a major oil and gas company. Implementing the activity requires program effort from senior management to the online operators in an organized and consistent way. The major program components of a loss control program are described, and include managerial support, technical support, training, event reporting, data analysis, and actions to commend and correct. A disciplined system of follow-up on recommendations is required. Application of loss control will ultimately reduce operational costs by improving program effectiveness, and will also affect more traditional loss control indicators such as recordable injury frequency and preventable vehicle accident frequency. Determination of the true value of a loss control program, however, requires a more detailed information base analyzed in a way which identifies the most relevant components of the program, which should be followed to meet the specific needs of the company. 4 refs., 4 figs., 1 tab.

50467 (CONF-891185–1, pp. 37, Paper 2) **A decade of change in the Asia-Pacific region: The energy outlook and emerging supply/demand imbalance.** Fesharaki, F. (Resource Systems Institute, Honolulu, HI (USA)); Yamaguchi, N.D. East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

In this paper the authors examine the Asia-Pacific energy situation and the outlook for the regional oil and gas market, beginning with a look at the structure of the demand, the extent of the regional oil and gas resource, and the prospects for crude oil production through the year 2000. Following this is an assessment of the Asia-Pacific supply/demand balance (or imbalance, as the case may be), and the future of the regional refining sector. The pressure caused by an increase in environmental concerns also has a role in determining the direction of these supply sources.

50468 (DOE/EIA–0109(90/07)) **Petroleum Supply Monthly, July 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 28 Sep 1990. 127p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE91000841. Source: NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

Data presented in the PSM describe the supply and disposition of petroleum products in the United States and major US geographic regions. The data series describe production, imports and exports, inter-Petroleum Administration for Defense (PAD) District movements, and inventories by the primary suppliers of petroleum products in the United States (50 states and the District of Columbia). The reporting universe includes those petroleum sectors in Primary Supply. Included are: petroleum refiners, motor gasoline blenders, operators of natural gas processing plants and fractionators, inter-PAD transporters, importers, and major inventory holders of petroleum products and crude oil. When aggregated, the data reported by these sectors approximately represent the consumption of petroleum products in the United States.

50469 (DOE/EIA–0380(90/06)) **Petroleum marketing monthly, June 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 6 Sep 1990. 185p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE90017615. Source: NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.

The Petroleum Marketing Monthly (PMM) is designed to give information and statistical data about a variety of crude oils and refined petroleum products. The publication provides statistics on crude oil costs and refined petroleum products sales for use by industry, government, private sector analysts, educational institutions, and consumers. Data on crude oil include the domestic first purchase price, the f.o.b. and landed cost of imported crude oil, and the refiners acquisition cost of crude oil. Sales data for motor gasoline, distillates, residuals, aviation fuels, kerosene, and propane are presented. 12 figs., 49 tabs.

50470 (DOE/EIA–0520(90/09)) **International petroleum statistics report.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 28 Sep 1990. 42p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000149. Source: NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.

This report presents data on international oil production, consumption, imports, exports, and stocks. The report has three sections. Section 1 contains time series on world oil production, and on oil consumption and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1973, and monthly data for the most recent two years. Section 2 presents an oil supply/consumption balance for the market economies (i.e. non-communist countries). This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data beginning in 1982, and quarterly data for the most recent two years. 25 tabs.

50471 (DOE/EIA–0538(90/91-01)) **Winter fuels report: Week ending September 28, 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 4 Oct 1990. 73p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE91000698. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policymakers, consumers, analysts, and state and local governments on the following topics: distillate fuel oil net production, imports and stocks for all PADD's and product supplied on a US level; propane net production, imports and stocks for Petroleum Administration for Defense Districts (PADD) I, II, and III; natural gas supply and disposition, underground storage, and consumption for all PADD's; residential and wholesale pricing data for propane and heating oil for those states participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane Program; crude oil price comparisons for the United States and selected cities; and US total heating degree-days by city. This report will be published weekly by the EIA starting the first week in October 1990 and will continue until the first week in April 1991. The data will also be available electronically after 5:00 p.m. on Thursday during the heating season through the EIA Electronic Publication System (EPUB). 12 tabs.

50472 (DOE/EIA–0538(90/91-02)) **Winter fuels report, week ending October 5, 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 11 Oct 1990. 62p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE91000869. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policymakers, consumers, analysts, and state and local governments on the following topics: distillate fuel oil net production, imports and stocks for all PADD's and product supplied on a US level; propane net production, imports and stocks for Petroleum Administration for Defense Districts (PADD) I, II, and III; natural gas supply and disposition and underground storage, for the United States and consumption for all PADD's; residential and wholesale pricing data for propane and heating oil for those states participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane Program; crude oil and petroleum price comparisons for the United States and selected cities; and US total heating degree-days by city. This report will be published weekly by the EIA starting the first week in October 1990 and will continue until the first week in April 1991. The data will also be electronically after 5:00 p.m. on Thursday during the heating season through the EIA Electronic Publication System (EPUB). See page ii for details. 12 tabs.

50473 (DSPC–67084H-A) **Evaluation of the interests of Ogy Petroleums Ltd. in the Flatrock area.** D and S Petroleum Consulting Group Ltd., Calgary, AB (Canada). Mar 1990. 39p. (CE–03171). Source: PC Ogy Petroleums Ltd., 505 - 500 Fourth Avenue SW, Calgary, AB, CAN T2P 2V6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An evaluation is presented of oil and gas interests of Ogy Petroleums in the Flatrock area of British Columbia. The company's total proved, developed, and producing reserves in this area total 228,160 bbl of crude oil, 3,567 bbl of natural gas liquids, and 504 million cubic feet of marketable gas. Forecasts are made of future cash flow and product prices and the principles behind these projections are detailed. Capital and operating costs are shown in 1990 dollars, and costs used in production and revenue forecasts have been escalated by 5% to 1991 and 6% until 2005. Royalty information is also included. Individual forecasts are made for each of the company's four wells, and reservoir data are also provided. 5 figs., 18 tabs.

50474 (DSPC–67084H-B) **Evaluation of the interests of Ogy Petroleums Ltd. in the Flatrock area. Constant dollar case.** D and S Petroleum Consulting Group Ltd., Calgary, AB (Canada). Mar 1990. 32p. (CE–03172). Source: PC Ogy Petroleums Ltd., 505 - 500 Fourth Avenue SW, Calgary, AB, CAN T2P 2V6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An evaluation is presented of oil and gas interests of Ogy Petroleums in the Flatrock area of British Columbia. The company's total proved, developed, and producing reserves in this area total 228,160 bbl of crude oil, 3,567 bbl of natural gas liquids, and 504 million cubic feet of marketable gas. Forecasts are made of future cash flow and product prices at the constant-dollar case. Individual forecasts are made for each of the company's four wells, and reservoir data are also provided. 5 figs., 18 tabs.

50475 (MAC–13533D) **Evaluation of Canadian Angus Resources.** McDaniel and Associates Consultants Ltd., Calgary, AB (Canada). 1 Jan 1990. 76p. (CE–03168). Source: PC Canadian Jorex Limited, 2870 Bow Valley Square 4, 250 - 6th Avenue SW, Calgary, AB, CAN T2P 3H7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Estimates are presented of the crude oil, natural gas, and natural gas products reserves and their present worth values of the interests of Canadian Angus Resources in Alberta and British

Columbia. Total proven net reserves of crude oil and natural gas are estimated at 73,420 bbl and 1.136 million cubic feet respectively. The basis on which price forecasts are made, and the methods of provincial royalty calculation, are described in detail. Information on individual wells consists of percentage ownership, royalty rate, and estimated company share of reserves. 18 tabs.

50476 (P–300-90-003) **Quarterly oil report: Fourth quarter 1989.** California Energy Resources Conservation and Development Commission, Sacramento, CA (USA). Fossil Fuels Planning Office. Jul 1990. 59p. Sponsored by California Energy Commission. Source: OSTI; California Energy Commission, 1516 Ninth Street - MS 13, Sacramento, CA 95814.

This report contains information on petroleum fuels market activity in California. Included is information on price trends, refinery activities, production, and petroleum company financial statements. 10 fig., 6 tabs. (CBS)

50477 (ST–90-17) **Alberta oil and gas industry annual statistics, 1989.** Energy Resources Conservation Board, Calgary, AB (Canada). May 1990. 114p. (CE–03150). Source: Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: $30.00 CAN.

Data are presented on supply and disposition of various products of the Alberta oil and gas industry. Data for 1989 are listed in monthly form and annual historical data back to 1980 are also given. The types of products covered are crude oil and equivalent, natural gas, raw material and fuel, refined products, ethane, propane, butanes, natural gas liquids, and sulphur. Wells drilled during 1989, annual well counts, and drilling activity are also summarized. 23 figs., 21 tabs.

50478 (UA-DE-NSS-OP–28) **Economic and fiscal aspects of the development and decommissioning of new oil fields in the North Sea: a comparative study of the UK, Norway, Denmark and The Netherlands.** Kemp, A.G.; Kellas, G.K.; Reading, D. Aberdeen Univ. (UK). Dept. of Economics. Aug 1989. 77p. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The economic and fiscal aspects of new North Sea oil field developments in the UK, Norway, Denmark and The Netherlands are examined within the context of the size of the recoverable reserves and the proximity to infrastructure. Decommissioning obligations are included in the analysis and the fiscal treatment of these costs in the four countries is highlighted. The fiscal position of the investor is considered under two circumstances: (1) those of an existing taxpayer and (2) those of a new entrant with no taxable income. (UK).

50479 (UA-DE-NSS-OP–29) **The economics of field abandonment in the UKCS.** Kemp, A.G. Aberdeen Univ. (UK). Dept. of Economics. Aug 1989. 28p. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The abandonment of oil and natural gas fields in the North Sea raises a number of economic issues. These are principally (a) the costs incurred in the abandonment operations, (b) the criteria to be employed in determining the timing of field abandonment, (c) the fiscal reliefs available for the abandonment expenditures, and (d) the (financial) security aspects of the operation. These topics are briefly discussed in this paper. (author).

50480 (WPD–43623E) **Walking Stick Oil and Gas Ltd. Reserve and economic evaluation. Hoffer Pool properties - Saskatchewan.** W.P.D. Resources Ltd, Calgary, AB (Canada). 1 Nov 1989. 48p. (CE–03169). Source: PC Hollywood Investment Corporation, Suite 2460, 555 W. Hastings St., P.O. Box 12117, Vancouver, BC, CAN V6B 4N6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An evaluation is presented of proven reserves from 7 wells in southeastern Saskatchewan. Net recoverable reserves are estimated at 77,700 bbl (proven) and 28,700 bbl (probable). Cash flow projections were attributed to each well using the royalty burdens and operating costs discussed in the evaluation. Net present undiscounted value of the reserves is estimated at $866,400 (proven) and $454,200 (probable). Production history graphs for the 7 wells are also included. 7 figs., 11 tabs.

0208 Waste Management

Refer also to citation(s) 50335

50481 (CONF-900801–27) **Hydrogen sulfide waste treatment by microwave plasma dissociation.** Harkness, J.B.L.; Gorski, A.J.; Daniels, E.J. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90017664. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A new waste-treatment technology for hydrogen sulfide using a microwave-generated plasma to dissociate hydrogen sulfide appears to have a substantial economic edge over the current industrial technology. The advantage of the plasma process is that it can recover hydrogen, as well as sulfur, from hydrogen sulfide. Since the plasma process requires less energy to dissociate hydrogen sulfide than is needed to generate hydrogen, the new process will save a substantial amount of energy. Experimental results from the Soviet technical literature and Argonne National Laboratory indicate that the microwave energy required to dissociate pure hydrogen sulfide may be only slightly greater than its heat of formation. In addition, tests at Argonne with typical refinery sour gas compositions indicated the plasma waste-treatment process can dissociate hydrogen sulfide in the presence of carbon dioxide, water, and methane. 5 refs., 4 figs.

50482 (HBBT–R71-19/54-1988E) **Geophysical assessment of waste drilling fluid containment sites in the Mackenzie River Valley region, NWT.** Environmental studies, No. 54. Hardy BBT Ltd., Edmonton, AB (Canada). Apr 1988. 95p. (MICROLOG–90-04621). Source: PC Indian and Northern Affairs Canada, Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Drilling waste containment in eight abandoned sumps in the Mackenzie Valley region was assessed using geophysical methods. The major objectives of the study were to assess the performance of abandoned sumps in the containment of waste drilling fluids and to suggest improvements to the current practice of total containment. The assessment was carried out as a reconnaissance survey over a range of permafrost conditions. Geophysical electrical conductivity measurements were made at each sump, supplemented by surface soil analysis to assess any chemical expression of geophysically detected wastes. Notes were taken on site stability, signs of accelerated erosion, and the success of revegetation. Contour maps of apparent conductivity were prepared and surface soil analyses were correlated with apparent conductivities at each site. Evidence of waste fluid movement was assessed by evaluating apparent conductivity contours at each sump location. Because electrical conductivities are an indirect measurement of the salt concentration in the soil, evidence from other factors known to influence waste fluid containment and/or detectability were included in the assessment. These included the existence of permafrost, texture of subsurface materials, depth of water table, chemistry of the drilling fluids and surface contamination. Based on the collective evidence, each sump was given an overall contamination rating. On this basis, 6 sumps were rated as having some likelihood of leakage. Two of the sites had significant stability problems related to site selection. At only 3 of the sites was revegetation considered adequate. Recommendations were made concerning sump location criteria and the direction for future studies. 18 refs., 28 figs., 5 tabs.

50483 (SPE–1/PN/2) **Environmental code of practice for treatment and disposal of waste discharges from offshore oil and gas operations.** Canadian Seabed Research Ltd., Halifax, NS (Canada). Jan 1990. 102p. (MICROLOG–90-03086). Source: PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada,

555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This code presents Environment Canada's position on the level of waste treatment achievable at offshore oil and gas operations, utilizing the best practicable technology. The code is designed to provide an information base for Environment Canada staff and other people interested in waste treatment at offshore oil and gas facilities, as well as a guide to the industry and regulatory agencies designing and approving waste treatment facilities. The source, characteristics and treatment options available for each of the 15 potential waste streams are reviewed. Decommissioning is also discussed. Recommendations are made on the discharge concentrations and volumes achievable with the application of the best practicable technology. Potential design opportunities for new platforms are identified for specific waste streams; incorporation of these design opportunities may reduce the discharge of oil and other products to the marine environment. The management and control of chemical usage at offshore sites is discussed, with the view to establish a chemical notification scheme for Canada. A modified version of the British chemical notification scheme is appended for consideration. The rationale for compliance monitoring is also included, and recommendations are made to guide industry and government on the parameters to be sampled and on the frequency of sampling. 47 refs., 3 figs., 7 tabs.

50484 (WA–90-04401) **Petroleum industry waste management study: Phase 3. Priority waste characterization.** Wotherspoon and Associates, Calgary, AB (Canada); Bromley (David) Engineering Ltd., Edmonton, AB (Canada). Jun 1989. 97p. (MICROLOG–90-04401). Source: PC Canadian Petroleum Association, 3800 - 150 6th. Ave. S.W., Calgary, AB, CAN T2P 3Y7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

A total of 26 petroleum industry wastes were identified as needing further research to investigate the extent of waste characterization data available. These wastes were classified as priority wastes because they may be generated in large volumes, they have been previously been classified as hazardous on the basis of limited data, and they need to be classified properly for economically and legally acceptable disposal. Information on the priority waste characterizations was obtained from the literature, from laboratories and other institutions involved in waste analysis, and from correspondence with those in the petroleum industry and in government agencies. A review of the available analytical data indicates that there is currently no standardized or widely accepted sampling and analytical protocols for petroleum industry wastes. The waste classification data obtained from the aforementioned sources was extensively reviewed and summarized. The results are presented in the form of waste characterization sheets, giving waste names and synonyms as commonly used in the industry, chemical name(s), source of waste, significant components and average concentrations, analytical methods used, health hazards and safety information, indicated waste classification, and literature references. The wastes include filter wastes such as amines, glycol, lube oil, and produced water; sludges from sources such as gas sweetening, process ponds, and tank bottoms; and other wastes such as produced sand, wash fluids, and well workover hydrocarbons. 100 refs., 26 tabs.

0209 Environmental Aspects

Refer also to citation(s) 50433, 50482, 50497, 50949, 51011, 51688, 51693

50485 (CCG–TP2526) **Marine oil pollution response.** Canadian Coast Guard, Ottawa, ON (Canada). [1989]. 14p. (MICROLOG–90-04031). Source: PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This document outlines the responsibilities of the Canadian Coast Guard in dealing with oil spills on the coasts of Canada. A brief description of legislation concerning oil spills and spill clean up is presented. The behaviour of oil at sea is discussed, including its movement on the surface, 'weathering' effects, evaporation of its 'light ends' (components with a low boiling point), dissolution of its toxic constituents, emulsificaton, and oxidation of hydrocarbons. Canada's response capability is outlined. Equipment is purchased for three basic areas of operation. In order of priority they are equipment to transfer cargos from damaged vessels, shoreline protection and/or restoration, and open water recovery. The document concludes with a description of the equipment used and measures taken in dealing with an open water spill. Equipment includes portable inflatable booms, the FRAMO ACW-400 disc skimmer, transfer pumps, and oil dispersants.

50486 (MIC–90-03924/XAB) **Evaluation of the Beaufort Sea environmental assessment panel review.** Sadler, B. Federal Environmental Assessment Review Office, Hull, PQ (Canada). ©1990. 184p. (SSC-EN–106-14/1989). Source: NTIS, PC EE12/MF E01.

Text in English and French (Bilingual).

The final report of the Beaufort Sea environmental assessment panel was submitted in July 1984, concluding the lengthiest (4 years) and most comprehensive public inquiry conducted to date under the Federal Environmental Assessment and Review Process (EARP). The review also represented a significant expansion in the use of EARP for planning and management of northern development. For these reasons, the Review Office commissioned an evaluation of the Beaufort Sea experience to examine the policy and institutional implications of the mandate of the Beaufort Sea review; to analyze the operational effectiveness of review procedures, especially those that represent departures from conventional practice; and to consider the contribution of the panel's report to environment and development decision-making. This report examines the study strategy and research design; analyzes the role, practice, and impact of the panel review; and contains conclusions and recommendations on process development.

50487 (NRC–90-04411) **Permafrost and terrain research and monitoring: Norman Wells pipeline: Volume 1. Environmental and engineering considerations.** Environmental studies, No. 64. MacInnes, K.L.; Burgess, M.M.; Harry, D.G.; Baker, T.H.W. Department of Indian Affairs and Northern Development, Ottawa, ON (Canada); Department of Energy, Mines and Resources, Ottawa, ON (Canada); National Research Council of Canada, Ottawa, ON (Canada). Dec 1989. 164p. (MICROLOG–90-04411). Source: PC Indian and Northern Affairs Canada, Reference Centre, Les Terrasses de la Chaudie@'re, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The 869-km Norman Wells pipeline is the first completely buried oil pipeline in the discontinous permafrost zone in northern Canada. The pipeline project is subject to the principle of minimum practicable environmental and land use disturbance for all aspects from planning to abandonment. Permafrost and terrain monitoring was established to evaluate impacts and identify improvements for this and future projects. Major aspects of the monitoring program include examining thermal and terrain conditions at 23 instrumented sites, regular observations of overall right-of-way conditions, and reviewing the performance of wood chip insulation on thaw-sensitive slopes. The environmental and engineering considerations related to the pipeline design are summarized, including permafrost distribution and soil/vegetation regions, route selection and characterization, thaw settlement and frost heave phenomena, slopes and water crossings, drainage and erosion control measures, and revegetation of rights-of-way. The procedures used in constructing the pipeline from 1983 to 1985 are also described. A comparison is also made with other northern pipelines, notably the Trans-Alaska oil pipeline. 149 refs., 21 figs., 34 tabs.

50488 (OCS/EIS/EA/MMS–90-0063) **Beaufort Sea Planning Area oil and gas lease Sale 124: Final Environmental Impact Statement.** Minerals Management Service, Anchorage, AK (USA). Alaska Outer Continental Shelf Region. Sep 1990. 837p. Sponsored by U.S. Department of the Interior. Source: OSTI; Minerals Management Service, 949 E. 36th Avenue, Anchorage, AK 99508-4302.

This environmental impact statement (EIS) discusses a proposed oil and gas lease sale in the Beaufort Sea Planning Area, analyzes

its potential effects on the environment, describes alternatives, presents major issues determined through the scoping process and through the staff analyses, and evaluates potential mitigating measures. Alternative I, the proposed action is based on offering for lease about 4095 blocks in the Beaufort and Chukchi Seas that range from about 3 to 140 nautical miles offshore. Alternative II would cancel the proposed lease sale, tentatively scheduled for April 1991. Alternative III would delay the proposed lease sale for a period of 2 years. Alternative IV would defer leasing on 201 blocks that are located in the vicinity of Point Barrow. Alternative V would defer leasing on 143 blocks in the vicinity of Barter Island east to the Canadian boundary line. After a thorough review, the Secretary of the Interior will decide which alternative or combination of alternatives will be included in the Nctice of Sale.

50489 (PB–90-256546/XAB) **Use of surfactants in the bioremediation of petroleum-contaminated soils. Technical report.** Green, G. Kansas Univ., Lawrence, KS (USA). 1989. 30p. Source: NTIS, PC A03/MF A01.

Surfactants were considered as a possible method of increasing the rate of bioremediation of soils and groundwater contaminated with petroleum hydrocarbons. A large number of surfactants have been demonstrated to be biodegradable under aerobic conditions. Soil, petroleum hydrocarbons and surfactant interactions dictate that for a given set of conditions, only certain surfactants will significantly lower the surface and interfacial tensions and thus be effective. Emulsifiers have been found to increase the rate of bioremediation but have not been found to increase the extent of biodegradation to which a petroleum product will undergo. Most petroleum products are made up of a complex mixture of hydrocarbons. Different hydrocarbon compounds have been found to be biodegraded at differing rates. The rate and extent to which a particular constituent will degrade is based on its classification and physical properties.

50490 (PB–90-258609/XAB) **Outer Continental Shelf Environmental Assessment Program: Comprehensive Bibliography, June 1990.** National Ocean Service, Anchorage, AK (USA). Ocean Assessments Div. Jun 1990. 648p. Source: NTIS, PC A99/MF A04.

See also PB–88-212030.

The objectives of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) are as follows: To provide information about the OCS environment that will enable the Department of the Interior (DOI) to make sound management decisions regarding the development of mineral resources on the OCS; To acquire information that will enable DOI to identify those aspects of the environment that might be affected by oil and gas exploration and development; To establish a basis for predicting the effects of OCS oil and gas activities on the environment; and To acquire impact data that may result in modification of leasing stipulations, operating regulations, and OCS operating orders in order to permit more efficient resource recovery with adequate environmental protection. The bibliography is a compilation of publications and reports that have resulted from research funded by OCSEAP since its inception in 1975 and is an updated version of the Comprehensive Bibliography published in January 1988. Certain other publications that have appeared in other government documents, books, or refered literature relating to environmental problems associated with oil and gas development are included in the bibliography.

50491 (QS–8426-000-EF-A1) **Yukon fish and effects of causeways.** Environmental studies, No. 57. Department of Indian and Northern Affairs, Yukon, YT (Canada). Northern Oil and Gas Action Program. 1988. 148p. (MICROLOG–90-04620). Source: PC Indian and Northern Affairs Canada, Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The discovery of potentially commercial quantities of hydrocarbons in the nearshore waters of the Beaufort Sea and the MacKenzie Delta region has resulted in the possibility of construction of causeways. The purpose of this study was to produce a synthesis of the relevant information on the effects of causeways in the Prudhoe Bay/Sagavanirktok Delta region of Alaska on the distribution, movement and population levels of anadromous fish. This synthesis and the available data from the Yukon coast were then combined to assess the potential impacts of coastal structures on anadromous fish populations along the Yukon coast. The potential effects of the proposed causeways on the local oceanography are similar at both King Point and Stokes Point. During easterly winds, the westward transport of warm brackish water would be disrupted, and pools of cold, saline water would from on the west side of the structures. Alterations in the oceanography would be much less during periods of westerly winds. It is unlikely that the proposed structures at King Point and Stokes Point would affect large Arctic and least cisco, given the relatively small size of these structures and the swimming capabilities of these large individuals. However, the case for small Arctic and least cisco is not as clear, since there are insufficient data on the distribution and movement patterns of these groups to allow for a determination of the impacts of the proposed structures. Important data gaps are identified and recommendations for future studies are provided. In addition, a review of the present and historical positions, and views of the US regulatory agencies on the impacts of causeways on anadromous fish is provided. 107 refs., 20 figs., 7 tabs.

50492 **In-situ venting of jet-fuel-contaminated soil.** Elliot, M.G. (Air Force Engineering and Services Center, Tyndall AFB, FL (US)); DePaoli, D.W. pp. 1-10 of Proceedings of the 44th industrial waste conference. Lewis Publishers, Chelsea, MI (USA) (1990). pp. 951 (CONF-890526–: 44. annual Purdue industrial waste conference, West Lafayette, IN (USA), 9-11 May 1989).

The Air Force Engineering and Services Center is performing a field demonstration of in-situ soil venting at a 27,000-gallon jet fuel spill site at Hill AFB, Utah. In-situ soil venting is a soil cleanup technique which uses vacuum blowers to pull large volumes of air through contaminated soil. The air flow sweeps out the soil gas, disrupting the equilibrium existing between the contaminants on the soil and in the vapor. This causes volatilization of the contaminants and subsequent removal in the air stream. In-situ soil venting has been used for removing volatile contaminants such as gasoline and trichloroethylene, but a full-scale demonstration for removing jet fuel from soil has not been reported. This paper describes initial site characterization, the one-vent pilot test, and the design and preliminary results of our full-scale in-situ soil venting system.

0210 Legislation and Regulations

50493 **H.R. 3092: Oil Pipeline Regulatory Reform Act of 1989. Introduced in the House of Representatives, One Hundredth First Congress, First Session, August 2, 1989.** 28p. Government Printing Office, Washington, DC (US) (1989).

The bill would remove the burden of economic regulation from those oil pipeline markets that operate under competitive circumstances and would provide for continued economic regulation of only those oil pipeline markets for which such regulation will increase economic efficiency and for which the benefits of such regulation outweigh its costs.

0220 Transport, Handling, and Storage

50494 (CHOA–89304ACC0387, pp. 1-31) **Emulsions for short distance transportation of heavy crude oil: Pipeloop test results.** Gillies, R.G. (Saskatchewan Research Council, SK (Canada)); Shook, C.A. Canadian Heavy Oil Association (Canada). [1989]. (CONF-8911238–: Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association, Calgary (Canada), 14 Nov 1989; CE–03151). In *Heavy oil production and the environment.* vp. Source: Canadian Heavy Oil Association, 425, 808-4 Avenue S.W., Calgary, AB, CAN T2P 3E8. Prices: $35.00 CAN.

The effects of temperature and sand content on the flow resistance of high concentration heavy oil in water emulsions were studied experimentally. The flows were laminar in a recirculating flow test loop with pipe diameter 53 mm. At low temperature, a non-Newtonian flow resistance was evident. The effect of temperature could be explained through changes in the viscosity of the

brine used to prepare the emulsions. Sand in the oil either increased or decreased the flow resistance depending upon the amount of water present initially in the oil. Sand concentrations in the flow experiments were limited to 3% (mass) of the produced oil. The sand flowed in a distinct layer at the bottom of the pipe and the velocity necessary to transport the sand was strongly dependent on emulsion effective viscosity. Velocity distribution measurements and a finite element simulation showed that a region of low viscosity forms at the pipe wall as a result of oil droplet migration into the flow. 5 refs., 15 fig., 3 tabs.

50495 (CHOA–89304ACC0387, pp. 1-46) **Transport of heavy crude oil by water-continuous emulsions.** Browne, G.E. (Hydroflow Technologies Ltd. (Canada)); Hass, G.R.; Sell, R.D. Canadian Heavy Oil Association (Canada). [1989]. (CONF-8911238–: Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association, Calgary (Canada), 14 Nov 1989; CE–03151). In *Heavy oil production and the environment.* vp. Source: Canadian Heavy Oil Association, 425, 808-4 Avenue S.W., Calgary, AB, CAN T2P 3E8. Prices: $35.00 CAN.

The start-up of the infield pipline gathering system serving 2 Amoco Canada production pads near Elk Point, Alberta during September, 1988 is summarized, along with the operating conditions and hydraulic data obtained from the 14 months of operation of this pipeline system. The system uses Petroferm HO-FLOW 400 chemical to create a water-continuous emulsion to transport heavy, viscous crude oil from the production facilities to the cleaning plant. The 1.33 mile pipeline system was operated under various conditions. These conditions included: oil/water ratios from 0/100 to 80/20, flow rates from 63 bbl/h to 250 bbl/h per single pad, with total flows of 510 bbl/h from both pads, temperatures from 45-65°C, and active HO-FLOW 400 chemical concentrations from 75 to 500 ppM, based on the volume of oil. Operating pressures on the pipeline were consistently less than 100 psig for the emulsion, with apparent viscosities less than 150 centi poises. The free water knockout in the cleaning plant was designed to handle water-continuous emulsions. The spreader through which the fluid enters the free water knockout was raised to the oil/water interface. This keeps the water-continuous emulsion from dispersing in the water, causing water disposal problems. Water clarity and oil dryness have not been affected by the use of water-continuous emulsions. The pipeline is currently being operated at an oil/water ratio of 75/25. The pipeline ships approximately 250 bbl/h total fluid from each pad for 6-8 h/d, then is shutdown overnight. The current chemical concentration is 75-90 ppM active HO-FLOW 400 based on the oil volume. 22 figs., 8 tabs.

50496 (CIM/PS–CE03173, pp. 31.1-31.7, Paper 88-39-31) **Optimizing the flow rate of pumping Iraqi crude oil inside pipelines using a new drag reducing additive.** Aswad, Z. (Univ. of Baghdad (Iraq)); Mansour, A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A new drag reducing chemical additive made by GEM Solvent Inc. has been experimentally tested to minimize skin friction in turbulent pipe flow of Iraqi crude oil. Large-scale pipes of 1-, 2-, 3-, and 4-inch sizes have been used in the experiments. The effects of crude flow rate, pipe diameter and additive concentration on the rate of drag reduction were investigated. A friction reduction up to 63% has been achieved when 9 ppM of additive was added to crude oil. Friction reduction increases with increasing pipe diameter, crude oil flow rate, and additive concentration up to a certain limit. 4 refs., 6 figs., 1 tab.

50497 (OEB–90-04275-Ed.3) **Environmental guidelines for the location, construction and operation of hydrocarbon pipelines in Ontario.** Ontario Energy Board, Toronto, ON (Canada). 1989. 86p. (MICROLOG–90-04275). Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Ontario Energy Board (OEB) has jurisdiction, upon receiving applications, to authorize the construction of hydrocarbon transmission pipelines and related facilities within the province of Ontario. It can also authorize expropriation of land, if required, for pipelines and facilities. The Ontario Pipeline Coordination Committee (OPCC) minimizes the potential negative impacts of the construction and operation of hydrocarbon pipelines and facilities, in Ontario. This set of guidelines describes the responsibilities of the OEB and the OPCC and provides both a general and a specific guide to information needed to assess the impact of construction on agricultural lands, heritage resources, forest and flora, geological features and mineral resources, land use planning considerations, Crown land and areas of outdoor recreation, lake and watercourse crossings, and wildlife. The document also covers impact mitigation measures and the monitoring to be done after construction. Included is a listing of the relevant legislation and its general application. 2 figs.

0230 Properties and Composition

Refer also to citation(s) 50270

50498 (CIM/PS–CE03174, pp. 62.1-62.24, Paper 88-39-62) **Pressure-volume temperature correlations for Western Canadian gases and oil.** Asgarpour, S. (Gulf Canada Resources (Canada)); McLauchlin, L.; Wong, D.; Cheung, V. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Empirical correlations for the prediction of reservoir fluid properties have played a significant role in the design of petroleum production facilities and in reservoir engineering studies. The fundamental concept behind most of the empirical correlations is to estimate fluid properties such as solution gas-oil ratio, formation volume factor, and bubble point pressure as a function of field-measured quantities. These quantities include crude oil API gravity, gas specific gravity, flash gas-oil ratio, reservoir pressure and temperature. Recently the accuracy of several well-known correlations was investigated for 300 different fluid samples from western Canadian oil and gas reservoirs. The results indicated that in many cases the correlations were not accurate. This result was expected, as no correlations have ever been developed using fluid properties of western Canadian crudes. The objective of this study is to develop new sets of correlations to improve the accuracy of estimating physical properties and phase behavior for western Canadian crudes based on over 310 different samples from this region. Correlations were developed for different geological formations where sufficient data was available to warrant the statistical approach. The new correlations will improve the accuracy of estimating bubble-point pressure, formation volume factor, and solution gas-oil ratio for western Canadian crudes. 8 refs., 15 figs., 14 tabs.

50499 (NIPER–501) **National Institute for Petroleum and Energy Research quarterly technical report, July 1–September 30, 1990: Volume 1, Fuels research.** National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). 12 Oct 1990. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE91000884. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research programs from NIPER are briefly summarized. Topics include: Development of Analytical Methodology for Analysis of Heavy Crudes, and Thermochemistry and Thermophysical Properties of Organic Nitrogen- and Diheteroatom-Containing Compounds. 1 ref.

0250 Combustion

Refer also to citation(s) 51049, 51374

50500 (CIM/PS–CE03174, pp. 58.1-58.11, Paper 88-39-58) **Dry and wet combustion studies of different API gravity crude oils from Turkish oil fields.** Bagci, A.S. (Univ. of Bath (UK)); Okandan, E. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Dry and wet combustion tests were conducted using three different crude oils having 10.3, 12.4 and 28.4 API gravities. Experiments were carried out in a thin-walled vertical tube having 12.4 cm diameter and 124.5 cm length, which was packed with crushed limestone mixed with oil and water. Adiabatic control of the combustion tube was achieved during dry and wet combustion tests using external heaters and adiabatic control system. Throughout the experiments, temperature distribution, air and water injection pressures and rates, produced gas compositions and rate, and oil and water production were recorded. In the experiments average air flux was 23.0 $m^3/m^2/h$ and injected water-air ratio changed between 0.209 m^3/Mm^3 to 0.607 m^3/Mm^3. The average combustion front temperatures were not significantly affected by the injected water-air ratios for the experiments conducted. The atomic H/C ratio of the fuel decreased as the combustion peak temperatures increased. Under the adiabatic conditions of experiments, stabilized combustion front velocity increased due to injected water-air ratio. The air requirements and fuel consumption showed a decrease with decrease in API gravities of crude oils. The higher recoveries were obtained in wet combustion tests. 14 refs., 12 figs., 2 tabs.

50501 (STEV–1989-R24) **Small-scale combustion.** Schuster, R. Statens Energiverk, Stockholm (Sweden). Dec 1989. 37p. (In Swedish). Order Number DE91707871. Source: NTIS (US Sales Only), PC A03/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The aim of this report is to elucidate the best available combustion technique within the power range 100 kW to 5 MW, fuelled with oil, natural gas, chips, wood, briquettes, pulverized fuels or coal. Of special interest are figures concerning investment, and maintenance costs, performance efficiency and emission values.

03 NATURAL GAS

Refer also to citation(s) 50381, 50383, 50384

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 50386, 50387, 50389, 50391, 50394, 50400, 50401, 51886

50502 (DOE/MC/21179–2853) **Rock matrix and fracture analysis of flow in western tight gas sands: Final report.** Morrow, N.R.; Buckley, J.S.; Cather, M.E.; Brower, K.R.; Graham, M.; Ma, S.; Zhang, X. New Mexico Inst. of Mining and Technology, Socorro, NM (USA). New Mexico Petroleum Recovery Research Center. Feb 1990. 277p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-84MC21179. Order Number DE90009664. Source: NTIS, PC A13/MF A01 - OSTI; GPO Dep.

Low permeability gas sands are a vast future source of natural gas. The main problem in developing this resource is efficiently extracting the gas from the reservoir. The main objectives of this study were to develop new and improved core analysis techniques for measuring petrophysical properties of tight sands and to relate the measured properties to the rock pore structure. The project was subdivided into four major tasks concerned with advanced analysis of core from the Multiwell field experiment. Task I: Advanced core analysis included measurements of porosity (thin section vs. volumetric measurements), Klinkenberg permeability, surface area, and effect of overburden pressure, and pore structure investigations that included x-ray analysis and mineral analysis. Special consideration has been given to origin and types of pore structure. A new concept, the quality of pore space is introduced which is based on the degree to which identifiable pore space is occluded. This work has been greatly aided by application of transmitted light and epifluorescent microscopy. Task II: Gas Flow in Mineralized Fractures. Task III: Chemical Alteration. The control on permeability of the various minerals in MWX cores was investigated by studying the effect of various reagents on permeability and its sensitivity to confining pressure. Treatment ranged from flow of strongly acidic to strongly alkaline solutions; seven reagents were used. Task IV: Effect of Water on Gas Production. Many aspects of the effect of water on the petrophysical properties of tight gas sands were investigated under this task. These included, relative permeability, capillary pressure, imbibition, adsorption, and electrical conductivity. Comparison of the effect of confining pressure on distinctly different transport properties provides a test of the types of pore model appropriate to tight sands. 79 refs., 137 figs., 23 tabs.

50503 (PB–90-256488/XAB) **Study of worldwide natural gas resource and reserve estimation: NNEMS EPA question No. 1204. Technical report.** Ferguson, J.A. Brigham Young Univ., Provo, UT (USA). 1989. 102p. Source: NTIS, PC A06/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the U.S. Environmental Protection Agency. The estimation of natural gas resources and reserves is a complex, subjective scientific problem for which well-established, though expensive, techniques exist worldwide. The most important information for creating more accurate estimates is the abundance of exploratory cores and well log data. The United States, having spent more money and covered more ground exploring for gas than any other nation, produces relatively accurate gas estimates. World Oil and Oil and Gas Journal annually gather and publish information on worldwide gas reserves by sending questionnaires to all significant gas-bearing countries. In the U.S. the United States Geological Survey (USGS), the Potential Gas Committee, and the Minerals Management Service estimate domestic gas resources, while the Energy Information Administration and the American Gas Association gather information on domestic reserves. These estimates are generally accurate enough for planning and policy making. How economic and technological change will affect published reserves and resources is uncertain. All published estimates are based on current technology and economic conditions.

50504 Significance of coring-induced fractures in Mesaverde core, northwestern Colorado. Lorenz, J.C. (Sandia National Labs., Albuquerque, NM (USA)); Finley, S.J.; Warpinski, N.R. *AAPG Bulletin (American Association of Petroleum Geologists) (USA)*, 74(7): 1017-1029 (Jul 1990). DOE Contract AC04-76DP00789.

Several types of mechanically induced fractures occur in Mesaverde core from the US Department of Energy's Multiwell Experiment wells. Two of these types of fractures have significance for the determination of in-situ stress orientations. Scribe-line fractures originate at orientation grooves on the surface of the core and are initiated by scribing knives in the core barrel minutes after the core is cut free from the surrounding rock. In sandstone core, these fractures strike parallel to the maximum in-situ horizontal stress direction that has been determined in these wells by an elastic strain recovery measurements. Coring-induced petal and petal-centerline fractures form just below the advancing core bit. Their strike is also controlled by the in-situ stress field. Locally, however, strike may be secondarily influenced by shear stress created by bit rotation, reorienting petal fracture strikes in the direction of rotation. Nevertheless, in many situations the orientations of these two types of fractures may be used to determine the orientation of the horizontal in-situ stress field if the core is oriented. Even in unoriented core, the relative orientation between in-situ stress and natural fractures may be determined. 15 figs.

0303 Drilling, Production, and Processing

Refer also to citation(s) 50423, 50427, 50429, 50432, 50433, 50441, 50442, 50443, 50444, 50451, 50502

50505 (CIM/PS–CE03173, pp. 10.1-10.7, Paper 88-39-10) **South East Saskatchewan: Conservation of solution gas.**

Garvey, C. (Dome Petroleum Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Solution gas from south Saskatchewan oilfields is processed at five plants, whose historical development and current capabilities are described. The economic feasibility of exploitation of solution gas depends on gas volume and quality, capital investment, and access to markets. Gas/oil volume ratios vary from 25 to over 500, and typical gases found in the area contain about 55% methane and 40% higher hydrocarbons. Natural gas liquids content varies between 0.3 and 1.5 m^3 per thousand m^3 of gas. The capital investment requirements have been made attractive by the development and use of modular plants that can be installed at a cost of $35,000 per 1000 m^3/d of capacity, and pipelining costs range from a low of $20,000/km for 50 mm diameter. Other technological developments which have encouraged the installation of gas plants include the use of polyethylene pipe and low-differential-pressure vane compressors. Access to markets is provided generally by the Saskatchewan Power Corporation network, and access to market for gas liquids is through the terminal at the Steelman plant or by fractionation at the Nottingham plant. 2 refs., 1 fig., 2 tabs.

50506 (CIM/PS-CE03173, pp. 12.1-12.14, Paper 88-39-12) **Shell jumping pound: Optimizing sulphur plant operations via Linde Claus oxygen enrichment process.** Dreisenger, D.R. (Union Carbide Canada Ltd. (Canada)); Moffat, T.A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A commerical Claus oxygen enrichment system has been recently commissioned at the Jumping Pound Gas Processing complex located near Calgary, Alberta, following a successful demonstration program. Prior to oxygen enrichment, several seasonal problems plagued normal sulphur plant operations at the complex. These problems included insufficient air blower capacity, excessively high tail gas flows and, to a lesser extent, undesirably low reaction furnace temperatures due to low H_2S content in the acid gas feed. With oxygen enrichment, which has been commercially utilized at Jumping Pound since late 1987, it's apparent that all effects of oxygen enrichment upon the operation of the sulphur plant have been positive. Most notably, an instantaneous sulphur plant capacity increase of up to 60 tonnes/d may be achieved with Claus oxygen enrichment. The test program objectives and results, as well as enrichment facilities design and operation for both the test program and commercial program, are summarized. 10 fig., 2 tabs.

50507 (CIM/PS-CE03173, pp. 13.1-13.5, Paper 88-39-13) **Astra-Khan, the world's largest sour gas development.** Leipert, G.E. (Partec Lavalin Inc. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A review is presented of progress at the Astra-Khan sour gas field development in the Soviet Union. This project involved the collection of sour gas and condensate from 83 wells, and delivering 6 billion m_3/y of sour gas to the gas processing plant. Adverse conditions which had to be overcome included a highly corrosive raw gas (24% H_2S, 14% CO_2, and significant production of sour condensate and high-chloride water), a shut-in wellhead pressure of nearly 6000 psi, and a variation between summer and winter ambient temperatures of as much as 90°C in a remote desert environment. The general design of the field facilities was based on strategically located central collection points for sour gas and produced fluids. Details are provided on the specification, manufacture, and testing of the corrosion resistant pipe, fittings, and valves used in the project. Some information is also provided on the design of the control system, safety monitoring systems, and corrosion protection system.

50508 (CIM/PS-CE03173, pp. 34.1-34.8, Paper 88-39-34) **The maintenance control system (MCS) employed at the Fort Nelson Gas Plant.** Parkinson, G. (Westcoast Transmission Co. Ltd. (Canada)); Buuren, G. van. Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Fort Nelson gas plant in northern British Columbia is the largest plant in the Westcoast Transmission system. The remote location and the essential utility status of the plant result in an unusually difficult environment to plan and schedule maintenance work. A need was identified to establish a maintenance control system at the plant to provide better reliability of plant equipment, satisfy requirements for reportability of maintenance activities, and control maintenance costs. The system was first implemented manually by restructuring the maintenance department, identifying and coding all equipment, establishing a work request paper flow system, and establishing a preventive maintenance program. The system was then computerized using the mainframe-based company-wide system created in-house. Parallel operation of the manual and the computerized systems for 2 months before actual implementation aided in solving many software problems. The new system is considered an unqualified success; the maintenance budget was reduced from $8.5 million in 1980 to $6.5 million in 1985, the maintenance craftsmen have become more efficient, and equipment reliability has improved. 3 figs.

50509 (CIM/PS-CE03174, pp. 42.1-42.23, Paper 88-39-42) **Transient and steady-state aspects of gas condensate well performance.** Chopra, A.K. (Amoco Production Co. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Several important reservoir engineering aspects of gas condensate well performance are investigated using an IMPES (Implicit Pressure Explicit Saturation) compositional simulator which employs a modified Redlich-Kwong equation of state to describe phase equilibria. These aspects are the total hydrocarbon fluid production rate, saturation and pressure profiles, gas-oil ratio, and produced fluid compositions. The simulations are performed using a gas condensate fluid from a reservoir in the Overthrust Belt. The initial condition is a constant reservoir pressure. Simulations include transient state when two-phase flow occurs, and steady-state when the flowing phase composition becomes constant. Both radial and linear systems are examined. Excellent agreement between the results of the compositional simulator at steady-state/near steady-state conditions and two-phase steady-state theory is obtained. A step-by-step procedure to compute performance of gas condensate wells using the two-phase steady-state theory is illustrated. It is shown that the two-phase steady-state theory is a satisfactory approach for predicting the performance of gas condensate wells once the criteria for steady-state are satisfied. The conventional criteria to determine when steady-state is achieved for single phase systems are not applicable to two-phase gas condensate systems. Based on a study of the produced fluid compositions and the areal extent of the two-phase region, criteria for steady-state are suggested. A compositional simulator is needed to model transient conditions. The valuable applications of the two-phase

steady-state theory are to validate a simulator and evolve new techniques for two-phase pressure transient analysis techniques. 16 refs., 28 figs., 2 tabs.

50510 (CIM/PS–CE03174, pp. 51.1-51.35, Paper 88-39-51) **Panther River Well stimulations: A case history.** Milligan, M.R. (Shell Canada Ltd. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

During 1986 two large volume stimulation treatments were carried out on two low permeability Panther River (Alberta) wells. The formation treated in both wells was the Mississippian Turner Valley, a thrust faulted dense dolomite reservoir rock containing sour gas (average 6% H_2S) and found at about 4500 m. Panther River #2, a previously uncompleted well because of poor reservoir quality, was stimulated with a staged gelled pad, retarded-acid frac. Panther River #7, a suspended well with non-commercial deliverability, was stimulated with a massive propped frac using crosslinked HPG (hydroxy-propyl-guar) frac fluid and 40/60 sand. One of the objectives of these tests was to evaluate the response of these low permeability Panther River wells to the different stimulation techniques. The propped frac conducted on Panther River #7 was a mechanical success in that 300,000 lb of 40/70 proppant was placed in the formation. The short propped frac length (25 m) is very difficult to explain. It would appear that proppant placement is difficult and that this behaviour may be related to the naturally fractured nature of the dolomitic formation and the lack of vertical containment barriers. Acid-fracing appears to hold the best promise for stimulation of the Turner Valley rock in Panther River. In Panther River #2, an etched frac length of 61 m was achieved versus the 107 m strived for. The crosslinking and pump rate difficulties both detracted from achievement of the designed frac length. Nevertheless recoverable reserves were increased from 28% to 35% of original gas in place. Pre and post-frac flowing and pressure buildup tests were very useful in evaluating the results of the fracs. 23 refs., 9 figs., 13 tabs.

50511 (NRC–29895, pp. 259-278) **A study on dry cellulose acetate membrane for the separation of carbon dioxide/methane gas mixtures.** Chen, Y.; Fouda, A.E.; Matsuura, T. National Research Council of Canada, Ottawa, ON (Canada). 1989. (CONF-8806495–: Symposium on advances in reverse osmosis and ultrafiltration, Toronto (Canada), 7-10 Jun 1988; CE–03179). In *Advances in reverse osmosis and ultrafiltration.* 598p. Source: Canada Institute for Scientific and Technical Information, Montreal Rd., Ottawa, ON, CAN K1A 0R6. Prices: PRICES UPON REQUEST.

The permeation rate of helium, CO_2 and methane gases was studied using cellulose acetate membranes dried from water-wet reverse osmosis membranes by the solvent exchange method. The plot of the pure gas permeation rate versus pressure indicates that the surface flow dominates CO_2 permeation, while Knudsen flow dominates helium permeation. Surface flow can not be ignored with respect to methane gas. The plot of CO_2 and methane permeation rates versus helium permeation rate allows for the selection of membranes with the least permeability. Analysis of experimental data obtained from the least permeable membranes revealed that the surface viscosities of CO_2 and methane gas molecules are lower than those of organic liquids. An increase in viscosity was observed with an increase in gas molecule density. A transport model which includes surface, Knudsen, skip and viscous flow mechanisms allows generation of patterns of CO_2 and methane permeation rates as functions of helium permeation rate. 17 refs., 8 figs., 2 tabs.

0305 Health and Safety

Refer also to citation(s) 50679, 51881

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50394, 50457, 50459, 50463, 50464, 50466, 50467, 50471, 50472, 50473, 50474, 50475, 50477, 50479, 50518

50512 (CIM/PS–CE03173, pp. 8.1-8.8, Paper 88-39-08) **Determinants of western Canadian natural gas field prices.** Friedenberg, B. (Brent Friedenberg Associates Ltd. (Canada)); Nixon, A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Canadian experience with natural gas price deregulation is described, contrasting the current deregulated price environment with the environment prevailing before November 1986. The competitive model of natural gas price determination is first reviewed, followed by an analysis of field prices currently being paid in Canada. It is shown that following deregulation, the variation in prices paid by major shippers for Alberta gas increased considerably. The difference in prices can be explained by differences in market prices, access to markets, and transportation costs between Canadian producing areas and market areas. The competitive model of price determination would argue that within any producing area there should be a tendency for prices of equivalent termed gas (i.e. spot of firm contract) to equalize. Since deregulation, the major impediment to this process has been the constraints to market access, particularly the inability to secure pipeline transportation service. However, these constraints are gradually being removed and in the process the spread of natural gas field prices paid in Canada will narrow. 2 figs., 3 tabs.

50513 (CIM/PS–CE03175, pp. 97.1-97.21, Paper 88-39-97) **Developments in ethane supply and demand.** Mathieson, G. (Marenco Consulting Ltd. (Canada)); Sutherland, J. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03175). In *Applied vision: Realizing our potential: Volume 3.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A perspective is offered on Alberta ethane supply and demand, and the implications of Alberta government policy on ethane are explored. The actual ethane supply which is significantly below the potential economic supply, has consistently exceeded demand. Straddle plants have been the dominant source of ethane and are expected to continue to dominate; their production is forecast to rise to 147,000 bbl/d by 1995 and remain constant for the rest of the decade. Current field plant production comes from 12 plants, which mainly produce for the miscible-flood market; production is forecast to stay in the 60-70 thousand bbl/d range until the late 1990s, when it should decline significantly. Ethane demand has increased from 2,000 bbl/d in 1977 to 180,000 bbl/d in 1988 and has developed in 3 basic areas: petrochemicals, miscible-flood requirements, and exports. Petrochemical demand is forecast to rise to about 138,000 bbl/d by 1994 and remain constant thereafter; miscible flood demand is expected to decline significantly from the 1990 level of 97,000 bbl/d to 8,000 bbl/d by the year 2000. The collapse of the Ohio ethane market by 1986 has reduced the foreseeable export demand to a nominal amount. If there is a supply constraint, it should be only for a short period ending by 1992. The existing straddle plant system supply does not seem to be threatened in any way. In view of an overall ethane surplus which seems to be developing, it would be in the long-term interest to encourage increased use of miscible floods. This would assist in the restoration of a functioning ethane market and would not result in a loss of ethane, since most of this ethane is eventually recovered. 2 figs., 5 tabs.

50514 (UG–CE03163) **Union Gas annual report, 1988.** Union Gas Ltd., Toronto, ON (Canada). 1988. 46p. (CE–03163). Source: Union Gas Limited, 50 Keil Drive North, Chatham, ON, CAN N7M 5M1. Prices: N/C.

Union Gas Limited is Canada's third largest natural gas transmission system, serving over 550,000 residential, commercial and industrial customers in southern Ontario. It owns and operates a fully integrated system of storage, transmission and distribution facilities to serve the communities situated in an area stretching from Windsor in the west to Oakville in the east and from Owen Sound in the north to the Lake Erie shore in the south. Union Gas also stores and transports natural gas for other utilities in Ontario and Quebec, and for TransCanada PipeLines. Union operates Canada's largest underground natural gas storage facility, consisting of 10 pools located south of the Sarnia area having a capacity of 2,842 million m^3. Without these storage areas, winter demand for gas in Ontario and Quebec could not be met with existing transmission capacity. This annual report presents a view of the company's activities in gas supply and marketing, operations, engineering, and regulatory affairs. Financial statements are also included. Highlights of 1988 include renegotiation of a gas supply agreement with TransCanada PipeLines, a large increase in customers choosing direct purchase under the new deregulated pricing environment, and an increase in sales of 5.3% over 1987. 5 figs., 3 tabs.

50515 (UG–CE03164) **Union Gas annual report, 1989.** Union Gas Ltd., Toronto, ON (Canada). 1989. 44p. (CE–03164). Source: Union Gas Limited, 50 Keil Drive North, Chatham, ON, CAN N7M 5M1. Prices: N/C.

Union Gas Limited is Canada's third largest natural gas transmission system, serving over 570,000 residential, commercial and industrial customers in southern Ontario. It owns and operates a fully integrated system of storage, transmission and distribution facilities to serve the communities situated in an area stretching from Windsor in the west to Oakville in the east and from Owen Sound in the north to the Lake Erie shore in the south. Union Gas also stores and transports natural gas for other utilities in Ontario and Quebec, and for TransCanada PipeLines. Union operates Canada's largest underground natural gas storage facility, consisting of 10 pools located south of the Sarnia area having a capacity of 2,968 million m^3. It also has a partial ownership interest in another storage pool providing an additional 62 million m^3 capacity. Without these storage areas, winter demand for gas in Ontario and Quebec could not be met with existing transmission capacity. This annual report presents a view of the company's activities in gas supply and marketing, operations, engineering, and regulatory affairs. Financial statements are also included. Highlights of 1989 include expansion of the gas storage and transmission system by adding new pipeline loops and compressor facilities, securing of a long-term gas supply agreement with Western Gas Marketing Limited, and an increase in sales of 5% over 1988. 6 figs., 4 tabs.

50516 (UG–CE03165) **Union Gas annual report, 1990.** Union Gas Ltd., Toronto, ON (Canada). 1990. 48p. (CE–03165). Source: Union Gas Limited, 50 Keil Drive North, Chatham, ON, CAN N7M 5M1. Prices: N/C.

Union Gas Limited is Canada's third largest natural gas transmission system, serving nearly 600,000 residential, commercial and industrial customers in southern Ontario. It owns and operates a fully integrated system of storage, transmission and distribution facilities to serve the communities situated in an area stretching from Windsor in the west to Oakville in the east and from Owen Sound in the north to the Lake Erie shore in the south. Union Gas also stores and transports natural gas for other utilities in Ontario and Quebec, and for TransCanada PipeLines. Union operates Canada's largest underground natural gas storage facility, consisting of 12 pools located south of the Sarnia area having a capacity of 3,161 million m^3. Without these storage areas, winter demand for gas in Ontario and Quebec could not be met with existing transmission capacity. This annual report presents a view of the company's activities in gas supply and marketing, operations, engineering, and regulatory affairs. Financial statements are also included. Highlights of 1990 include opening of the St.Clair pipeline to enable connection of Union Gas facilities with those of Michigan Consolidated Gas; installation of additional pipeline loops and compressors; the bringing into operation of two new gas storage pools; and a slight decrease in revenues from 1989. 6 figs., 4 tabs.

0307 Waste Management

Refer also to citation(s) 50483

0308 Environmental Aspects

Refer also to citation(s) 50433, 50488, 50490, 50949, 51011, 51688

50517 (DOE/EA–0460) **Finding of no significant impact; Atlantic Richfield Company and Intalco Aluminum Corporation.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). [1990]. 18p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE91000833. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

On February 27, 1989, the Department of Energy (DOE) issued Opinion and Order No. 301 to Atlantic Richfield Company (ARCO) conditionally authorizing the importation of Canadian natural gas for use in its refinery near Ferndale, Washington. On February 28, 1989, the DOE issued Opinion and Order No. 302 to Intalco Aluminum Corporation (Intalco) conditionally authorizing the importation of Canadian natural gas for use in its aluminum smelting plant near Ferndale, Washington. However, both conditional orders provided that the issues raised in the proceedings would be reexamined upon subsequent completion of National Environmental Policy Act (NEPA) requirements for the Ferndale Pipeline project and that the final action would then be taken on the conditional orders. The DOE reviewed the project and determined that the pipeline project would not affect the quality of the environment.

50518 (PB–90-259979/XAB) **Evaluation of water-injection impacts for gas-turbine NOx control at compressor stations. Topical report, June-September 1989.** Castaldini, C. Acurex Corp., Mountain View, CA (USA). Environmental Systems Div. Jun 1990. 63p. Contract GRI-5083-51-0843. Source: NTIS, PC A04/MF A01.

Acurex reviewed and analyzed data on operational impacts of water injection to control NOx emissions from gas turbines used in gas compression service and developed cost estimates. At a water/fuel (W/F) ratio of 1.0, weight basis, NOx from gas turbines can be reduced by as much as 70 to 80 percent. The performance is accompanied by a thermal efficiency loss of 2 to 3 percent and an increase in CO and hydrocarbon emissions. Although water injection is a mature technology that has been in use for about 15 years on numerous utility and cogeneration installations, operational experience and cost data for application on gas transmission engines are lacking. Costs published to date for water injection have not sufficiently addressed the incremental cost of increased turbine maintenance. Additionally, the cost to secure large quantities of water at remote locations, where many existing compressor station turbines operate, can significantly impact the economics of retrofit project. The life-cycle costs for such retrofit were estimated in the $8,000 to $12,000 per ton of NOx removed, influenced by site-specific factors such as water availability and quality, size of engine, degree of NOx control, and increased maintenance.

50519 (PB–90-260480/XAB) **Effect of rangetop burner design on NO_2 emissions. Final report, February 1986-March 1987.** Reuther, J.J. Battelle Columbus Div., Washington, DC (USA). Feb 1990. 80p. Contract GRI-5084-253-1044. Source: NTIS, PC A05/MF A01.

The report details the methodology and results of a program at Battelle to evaluate the extent to which rangetop burner design and operation influence the emission of trace quantities of nitrogen dioxide (NO_2). A critical literature review revealed that conclusions drawn from previous research were ambiguous. New experiments here indicated that previous data were conflicting because the apparent amount of NO_2 observed was not only burner design- and operation-specific, but also NO_2-measurement protocol- and source-specific. Moreover, previously used NO_2 measurement protocols had not been standardized, and previously used NO_2 sources, production rangetop appliances, were not appropriate as research tools. After developing and validating a standardized NO_2 measurement protocol and an appropriate rangetop burner research tool (Uniburner), parametric experiments isolated the individual effects of various burner design and operating parameters. Low NO_2 emissions are favored by the use of cast-iron rather than

stamped-aluminum burner caps, lower port loadings at any firing rate, higher primary aeration, and lower peripheral secondary aeration. Thermophysical properties of burner caps (thermal conductivity and thermal mass) appear to control NO_2 emissions more than any other single or combination of burner design or operating parameter(s).

0320 Transport, Handling, and Storage

Refer also to citation(s) 50517, 50518

50520 (STEV–1989-R20) **Methane losses from natural gas utilisation.** Statens Energiverk, Stockholm (Sweden). Nov 1989. 52p. Order Number DE91707863. Source: NTIS (US Sales Only), PC A04/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

In the regional distribution of world natural gas consumption the overall pattern is dominated by Eastern Europe (mainly the USSR) at 40% of the total, and North America with 29%. The next most important consuming region is West Europe, at 13%, and the sum for the rest of the world comes to 18%. Because the issue of methane as a greenhouse gas is relatively recent, it is only in the past year or so that efforts have been made to get realistic overall loss figures, and there is understood to be a good deal of on-going work which has not been published. For other reasons, the gas industry has made major efforts to minimise any leakage. The gas industries in Western Europe and the USA generally estimate that losses are less than one percent of gas delivered. The largest proportion of losses comes in the local distribution stage, with low losses from national-level transmission. However, in the most important producing country, the USSR, figures are quoted which indicate losses of about 2% in the transmission system alone, and also high losses in local distribution. It should be noted that very little gas is distributed direct to households in the USSR, with power station and industrial use predominating, minimising the impact of losses in local distribution networks. An approximate estimate of global loss of methane to the atmosphere from the operations of production, transport and utilisation of natural gas is estimated 25.6 BCM (billion cubic meters) per year. Of this total, the largest contribution, at 36%, comprises the estimated losses from the Soviet transmission system. Unfortunately, this is one of the most uncertain part of the estimate.

50521 (TP–9470E) **Research of acoustic emissions in natual gas vehicle storage cylinders.** CWG Fuel Systems Ltd., Brampton, ON (Canada). 30 Oct 1987. 58p. Contract TP T8080-6-3115/01-SZ. (MICROLOG–90-04488). Source: PC Health and Welfare Canada, Communications Directorate, Brooke Claxton Bldg, Ottawa, ON, CAN K1A 0K9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Acoustic emission testing (AET) has been proposed as an alternate method of detecting cracking and corrosion in compressed natural gas (NGV) cylinders. AET is based on the theory that a crack emits a characteristic acoustic signature which can be transduced and recognized. An AET monitoring system would acoustically monitor a cylinder during filling and would reject the cylinder if it recognized the crack signature. Advantages of AET are that it doesn't require cylinder removal from the car, it doesn't over-pressure the cylinder as does standard testing procedures and it could be performed every time the vehicle is filled. The purpose of this study was to induce severe, accelerated corrosion and to monitor the cylinder's acoustic emissions from initial pressurization until the cylinder fractured. Testing was performed outdoors at Canadian Forces Base, Borden. The cylinder did corrode, crack and burst. Thus, active cracking was created by the corrosive charge. It was found that cylinders are acoustically active during and after filling; AET appears able to recognize the presence of a crack; AET may not be able to predict remaining life before burst; AET may not be able to predict imminent failure; further work with a larger sample size is indicated; and further theoretical analysis is required to formulate the minimum set of conditions under which AET can be reliably used. 13 refs., 26 figs., 4 tabs.

0340 Combustion

Refer also to citation(s) 50501, 50519

04 OIL SHALES AND TAR SANDS

Refer also to citation(s) 50381, 50383, 50384

50522 (CHOA–89304ACC0387) **Heavy oil production and the environment.** Canadian Heavy Oil Association (Canada). [1989]. vp. (CONF-8911238–: Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association, Calgary (Canada), 14 Nov 1989; CE–03151). Source: Canadian Heavy Oil Association, 425, 808-4 Avenue S.W., Calgary, AB, CAN T2P 3E8. Prices: $35.00 CAN.

A meeting was held to discuss various aspects of heavy oil production and environmentally related issues. Papers presented results of research, mainly in Alberta on wildlife interactions with pipelines, transport of heavy oil emulsions through pipelines, disposal of produced sand, cleanup of soil contaminated with oily waste, and utilization of oil sand tailings in road surfacing. Separate abstracts have been prepared for 5 papers from this meeting.

0402 Reserves, Geology, and Exploration

Refer also to citation(s) 50387, 50388

0403 Drilling, Fracturing, and Mining

Refer also to citation(s) 50406

50523 (CIM/PS–CE03185) **Horizontal well seminar.** Petroleum Society of CIM, South Saskatchewan Section, Regina, SK (Canada). 1989. vp. (CONF-8904383–: Horizontal well seminar, Calgary (Canada), 20 Apr 1989; CE–03185). Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A seminar was held to present results of Canadian experience and research on various aspects of horizontal oil wells. Papers were presented at the conference on subjects including directional drilling in oil sands, drilling muds and formation damage, well completion, pilot projects, comparison of vertical and horizontal well performance, and underground well test facilities. Separate abstracts have been prepared for 2 papers from this seminar.

50524 (CIM/PS–CE03185 vp.) **General considerations for drilling horizontal wells.** Robson, D. (Sperry-Sun (Canada)). Petroleum Society of CIM, South Saskatchewan Section, Regina, SK (Canada). 1989. (CONF-8904383–: Horizontal well seminar, Calgary (Canada), 20 Apr 1989; CE–03185). In *Horizontal well seminar.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Horizontal wells have numerous benefits for production from western Canadian oil sand deposits. The most common benefits are increased formation exposure per wellbore and wellbore isolation from bottom water drives. Typical oil sand formations are thin (2-18 m) found at 400-750 m total vertical depth. Most operators that have drilled successful horizontal wells in the western Canadian oil sands have used a long radius profile. This has the advantages of not needing specialized equipment, accurate navigation in thin formations, ability to achieve longer horizontal sections and to allow a greater number of services to be performed during drilling, and availability of a large range of hole sizes. Guidelines are offered for choosing a well profile and contingency planning for a horizontal well drilling operation. The most efficient way to drill long radius profiles is to use a steerable bottom-hole assembly, and the components of this assembly are described. Aspects of the drilling process are then reviewed, including directional surveys, communications with the drill crew, drilling the curve, and drilling the horizontal interval. 5 figs.

50525 (CIM/PS–CE03185, pp. 12) **Drilling mud related considerations for horizontal wells in heavy oil reservoirs.** Zeidler, H.U. (Mission Mud Control Ltd. (Canada)). Petroleum Society of

CIM, South Saskatchewan Section, Regina, SK (Canada). 1989. (CONF-8904383--: Horizontal well seminar, Calgary (Canada), 20 Apr 1989; CE-03185). In *Horizontal well seminar.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A number of observations indicate that either drilling mud, drilling or completion related practices could influence productivity or production from wells drilled in heavy oil reservoirs. The mechanisms of formation damage and other factors which may affect such production are described with special reference to horizontal wells. The phenomena discussed include alteration of permeability and wettability, blockage of the formation by the combining of drilling mud filtrate with the reservoir oil to form an emulsion, clay hydration and dispersion, drilling mud solids intrusion and migration, formation particle migration, and sand production. The effects of differential pressure between the wellbore and the formation are also assessed. A special phenomenon not existing in vertical wells is the formation of a cuttings bed on the low side of the wellbore, and methods of controlling this phenomenon are examined. Recommendations are made for minimizing formation damage in horizontal wells. 4 figs.

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 50407, 50431

50526 (CIM/PS-CE03173, pp. 16.1-16.16, Paper 88-39-16) **Effect of bottom and top water on cyclic steam stimulation response.** Farouq Ali, S.M. (Univ. of Alberta, Edmonton, AB (Canada)); Kasraie, M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

In many heavy oil reservoirs in Alberta and Saskatchewan, a high water saturation zone occurs below or above the oil zone. Such water zones can take a number of forms, and in special circumstances can even be beneficial. However, in most cases, they cause channelling in steam injection operations, leading to low oil-steam ratios. Cyclic steam stimulation, particularly in the presence of high water saturation zones, has been examined with the results based upon simulation studies for Lloydminster and Cold Lake reservoirs. It is shown that cyclic steam stimulation response depends strongly on water-oil zone thickness and permeability ratios, vertical permeability, oil viscosity, steam injection rate, and steam injection interval. Partial penetration is one of the operations that can help when thick contiguous water zones are present. For a given set of circumstances, operation may still be viable in the presence of a communicating water zone. Top water is likely to be more undesirable than bottom water, in view of migration of oil into the water zone above. 1 refs., 12 figs., 2 tabs.

50527 (CIM/PS-CE03173, pp. 17.1-17.15, Paper 88-39-17) **Verification of scaling approaches for steam injection experiments.** Kimber, K.D. (Alberta Research Council, AB (Canada)); Farouq Ali, S.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Three sets of new scaling criteria for high pressure steam injection experiments were derived and tested in a unique series of experiments. Unlike previous scaling criteria for steam injection, which require the use of porous media and pressure conditions different from the field, the present criteria permit the use of reservoir rock, fluids, and pressure conditions. Two of the new approaches relax some of the geometric scaling groups in order to satisfy other scaling requirements. To examine the suitability of these three new scaling approaches as well as a widely used approach from the literature, results from a large model were compared with those of smaller models scaled by the appropriate scaling approach. The scaled models, representing one eighth of a five-spot pattern, were designed to simulate steamflooding of a prototype heavy oil reservoir in Alberta. This series of experiments examined the scaling of the mechanism for heat transfer and steam zone development by injecting steam into a completely water saturated reservoir. Very good predictions of energy distribution, temperature distribution, production rate, steam zone volume, produced steam quality, and steam breakthrough were achieved for two of the scaling approaches. The ability of each approach to scale from one physical size to another is illustrated and the relative merits and potential applications of the approaches are discussed, leading to useful guidelines for the design of steam injection experiments. 4 refs., 14 figs., 2 tabs.

50528 (CIM/PS-CE03173, pp. 18.1-18.17, Paper 88-39-18) **In-situ emulsification by the condensation of steam in contact with bitumen.** Chung, K.H. (Univ. of Calgary, AB (Canada)); Butler, R.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Previous low-pressure experiments on the steam-assisted gravity drainage process using a scaled physical model showed more emulsification when the steam chamber was rising. Experimental results from an extension of that investigation are described. Included are the confirmation of the previous results using a higher steam pressure, and studies of the effect of connate water and steam quality. The experiments were performed in two-dimensional reservoir models with Cold Lake bitumen. The injection steam pressure was varied from 7.5 to 500 psig. The results show that the primary mechanism for in-situ water/oil emulsification involves the condensation of steam in contact with bitumen. Less emulsion is formed when the formation contains connate water. The quality of the injected steam and the nature of the porous packing did not change the degree of in-situ emulsification. The pressure of the injected steam had little effect on the emulsified water content of the produced fluid. As before, much more emulsion was formed when the steam chamber was rising. The retention of steam condensate in a formation initially completely filled with bitumen results in an irreducible water saturation. This irreducible water saturation was the same as that found in another experiment in which a water-filled reservoir was flooded with bitumen. 9 refs., 14 figs., 1 tab.

50529 (CIM/PS-CE03173, pp. 20.1-20.13, Paper 88-39-20) **Fracture stimulation in the GLISP [Gregoire Lake In-Situ Pilot Project] tar sands pilot: Case history.** MacKenzie, W.T. (Amoco Production Co. (Canada)); Moschovidis, Z.A.; Palmer, I.D. Petroleum Society of CIM (Canada). 1988. (CONF-8806494--: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE-03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Fracture stimulation of McMurray formation was perfomed during the Gregoire Lake In-Situ Steam Pilot Project (GLISP), in the Athabasca Deposit of northeastern Alberta. The purpose of the stimulations was to effect interwell communication between the injection and production wells prior to steam injection. In situ stresses, measured at shallow reservoir depths, indicated a possibility for horizontal fractures, a very desirable prerequisite for the potential success of the experimental pilot. Analyses of data collected during and following the final fracture stimulation in the pilot area on the central injection well (i.e., tiltmeter data, bottomhole pressures, temperature profiles, tracer surveys, production response, laboratory experience, field observations), and fracture theory indicate that a very complex fracture geometry resulted with both horizontal and vertical components. These data were used to address an array of nine possible fracture geometries to determine

the more probable fracture configuration(s). Interwell communication by hydraulic fracturing was achieved over short distances but not over the full well spacing of the pilot. 2 refs., 12 figs., 2 tabs.

50530 (CIM/PS–CE03173, pp. 21.1-21.18, Paper 88-39-21) **Evaluation and application of Pikes Peak cyclic steam injection pressure data.** Miller, K.A. (Husky Oil Operations Ltd. (Canada)); Given, R.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Cyclic steam performance at the Husky Pikes Peak steam pilot, producing oil from the Cretaceous Waseca Formation near Lloydminster, Saskatchewan, has been very good, but efforts to further improve performance have continued. A study was initiated to determine the causes of observed injection pressure variations from well to well, and during the stimulation of a given well. A further goal was to develop applications for this information. Analysis of the injection pressure data from pre-1985 wells was limited in scope due to the wide variations in injection rate and slug size, although the observed low injection pressures were correlated to the presence of gas caps or bottom water, and a stepwise pressure drop from cycle to cycle was documented. The relatively constant first cycle injection rates and slug sizes used for the 1985 wells allowed a more thorough analysis. Four injection pressure histories were observed: sustained high pressure and three types of pressure reduction. These pressure reductions were subsequently correlated to the proximity of: bottom water, gas caps, mature wells, and other recently stimulated first cycle wells. Therefore, injection pressure data can be used to supplement the reservoir description data obtained from logs and cores. First cycle data from the 1985 wells indicated that both overlapping the heated zones of previously stimulated nearby wells and pressure support from the aquifer could strongly affect first cycle well performance. Net pay appeared to have far less influence. The injection pressure history types of fourteen 1987 wells have been determined, and first cycle performance predictions have been made using the 1985 well data. 3 refs., 8 figs., 3 tabs.

50531 (CIM/PS–CE03174, pp. 61.1-61.38, Paper 88-39-61) **Injectivity enhancement in tar sands: A physical model study.** Sufi, A.H. (Amoco Production Co. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A scaled physical steamflood model was used to study ways of injecting heat into a highly tar-saturated reservoir, underlain by a tar-lean zone. This leaner zone provided limited injectivity into the reservoir a case often encountered in the field. Initially, an attempt was made to inject steam into the lower zone but this proved unsuccessful as the mass flowrate into the reservoir was too small. Next, hot water was injected into this zone which resulted in a gradual increase in the mass injection rate. When the injection was switched to steam, a sudden reduction in the mass injection rate was observed, causing a general cooling of the zones previously heated by hot water injection. The reduction in rate was caused by the higher kinematic viscosity of steam compared to hot water. Tests were conducted to determine the heating required by hot water injection before steam could be successfully introduced into the reservoir. Once it was possible to inject steam at high rates, high tar production rates were obtained from the model. A test was also conducted with the lean tar zone located at the top of the pay. For this case, the increase in tar production rate after switching from hot water injection to steam injection was less then for the case of steam injection into a basal zone. 16 refs., 26 figs., 5 tabs.

50532 (CIM/PS–CE03174, pp. 70.1-70.24, Paper 88-39-70) **Fracture geometries consistent with tiltmeter data and pressure and tracer communication in the GLISP [Gregoire Lake In-Situ Steam Pilot] I-1 stimulation.** Palmer, I.D. (Amoco Production Co. (Canada)); Moschovidis, Z.A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The Gregoire Lake In-situ Steam Pilot (GLISP), in the Athabasca tar sands, includes three producing wells surrounding an injection well. Studies were conducted to model tiltmeter records of the fracturing treatment of the central injection well, and pressure and tracer communication from the central injection well to the producing wells, and to investigate how these analyses support various fracture geometry scenarios. Several different fracture geometry scenarios have been examined. Theoretical surface tiltmeter vectors for these scenarios are compared with observed vectors. Also, theoretical time delays based on propagation of pressure transients and tracer material have been predicted for these scenarios, and compared with observed delays. The results of these comparisons are expressed in the form of a range of fracture geometries that are most consistent with measured tiltmeter data in the field, and pressure and tracer time delays in the three production wells. Interpretations within this range include complex fracture systems with at least one fracture component rising steeply from the base of the McMurray Formation into the overlying depleted zone. Dominant horizontal fracturing does not appear to occur. 4 refs., 19 figs., 3 tabs.

50533 (CIM/PS–CE03174, pp. 72.1-72.17, Paper 88-39-72) **Coupling of fluid flow and soil behaviour to model injection into unconsolidated oil sands.** Settari, A. (SIMTECH Consulting Services Ltd. (Canada)); Kry, P.R.; Yee, C.T. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Injection into unstimulated heavy oil reservoirs generally results in disturbance to the soil matrix. To correctly model the fluid distribution, the fluid flow behaviour must be coupled to the mechanical behaviour of the sands. A model has been developed representing the conditions present during isothermal leak-off from fracture face, accounting for the physics of this coupling. The model assumes that the minimum effective stress controls the soil behaviour and that the fluids are linearly compressible. The model satisfactorily represents fracture growth inferred from pressure observation wells and measured mean times for communication between cyclic steam stimulation wells. Several new features generated by the model can be correlated with field behaviour. Nonlinear compressibility of the oil sand at low effective confining stresses causes increases in porosity which explain observed injectivity with zero initial mobility. Shear failure occurs around a fracture primarily due to decreasing effective stresses as the local pore pressure increases. Dilatant failure behaviour increases porosity and permeability, producing plateaus of increased water saturation. The coupling of the fluid and solid mechanics in the new model represents a significant advance in the realism of modelling of fluid flow and fracturing in oil sands. 25 ref., 19 figs., 1 tab.

50534 (DOE/MC/11076–2835) **Laboratory evaluation of the effects of tar sand process water on aluminosilicate minerals.** Mason, G.M.; Daley, R.L.; Yin, P. Western Research Inst., Laramie, WY (USA). Mar 1988. 58p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90009668. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Laboratory experiments were conducted to determine the effects of tar sand process waters on the mineral components of a Utah sandstone (from a known tar sand deposit) and control samples of feldspars of varying compositions. Contact with the process water increased the porosity and permeability of the test samples, which

was caused by dissolution of aluminosilicate and carbonate minerals; there was a corresponding precipitation of clay minerals. Once mobilized, ions from the dissolved mineral matter can be moved by a processing wave and later precipitated as clay minerals when geochemical conditions change. Clay minerals can occlude porosity, affecting processing design and efficiency; additionally, they cause disposal and water recycling problems. 23 refs., 69 figs., 5 tabs.

50535 (NBRPC–90-03191) **Testing of New Brunswick oil shale in R.P.C. [Research and Productivity Council] test facility.** Salib, P. New Brunswick Research and Productivity Council, Fredericton, NB (Canada). Jan 1990. 102p. (MICROLOG–90-03191). Source: PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $5.10 CAN; MF $10 CAN.

Retorting trials were carried out on two oil shale samples from the Alberta Formation of southeastern New Brunswick. One sample is from the Alberta Mines zone (Fischer assay of 162 liter/tonne) and the other is from the Dolomite Marlstone Zone (Fischer assay of 54.5 liter/tonne). The test facility of the Reseach and Productivity Council is described and the trials are discussed, including the characterization of the retorting products (oils, gases, retorted shales, and process water). High oil recoveries were achieved. For the Alberta Mines sample, the yield was 101.2% of the Fischer assay, while that for the Dolomite Marlstone was even higher, at 134.5%. The product oils are light, with an American Petroleum Institute gravity in the range of 22.7 to 23.9. The distillation characteristics of the product oils indicate that New Brunswick shale oil would probably be a good feedstock for the production of gasoline, kerosene, jet and diesel fuels. Recommendations are made as to future research and development work in order to assess the potential of an oil shale mining and refining industry in New Brunswick, including the economics of such an industry. 11 refs., 2 figs., 13 tabs.

50536 **Kinetic simulation model for steam pyrolysis of shale oil feedstock.** Kavianian, H.R. (Argonne National Lab., Argonne, IL (US)); Yesavage, V.F.; Dickson, P.F.; Peters, R.W. *Industrial and Engineering Chemistry Research (USA)*, 29(4): 527-533 (Apr 1990).

Steam pyrolysis of shale oil feedstocks for the production of chemical intermediates was studied in a bench-scale tubular reactor. The results have been correlated as a function of temperature, residence time, and pyrolysis severity. The experimental results obtained upon pyrolysis of shale oil indicate that shale oil should make an excellent feedstock for steam pyrolysis.

0405 Properties and Composition

Refer also to citation(s) 50451, 50499

50537 (CIM/PS–CE03174, pp. 59.1-59.18, Paper 88-39-59) **A study of fines migration related permeability damage in extracted Cold Lake heavy oil cores.** Kwan, M.Y. (Esso Resources Canada Ltd. (Canada)); Cullen, M.P.; Jamieson, P.R.; Fortier, R.A. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

The purpose of this study was to quantify permeability impairment due to fines migration in extracted core material from the Clearwater Formation of Cold Lake, Alberta. Flow tests were conducted to compare the permeability behaviour of preserved cores with cores prepared from repacked reservoir material when each was exposed to fresh water and brine. The results of these experiments indicate that the absolute permeability of preserved core, typically between 1 and 3 Darcies, was not significantly affected when brine (NaCl or $CaCl_2$) alternating with fresh water was injected. Repacked tar sands cores, however, were found to have initially much lower absolute permeabilities and were suject to severe permeability damage, resulting in total plugging, when exposed to fresh water. Disturbance of the core material during repacking possibly results in the reorientation of fines particles and the destruction of naturally occurring flow paths. Repacked core was susceptible to large permeability reductions during flow regardless of whether the tar sand bitumen was extracted prior to or after the repacking operation. It is recommended that only preserved core be used for laboratory tests in which the results can be influenced by fines migration problems and native core chemistry. It should be noted that only high grade oil sand samples, i.e. about 12 weight % bitumen and 10% fines, from two wells were used in this study. As a result, the data may not be applicable to lower quality reservoirs. 8 refs., 7 figs., 2 tabs.

50538 (DOE/MC/11076–2832) **Characterization of volatile organic components in spent shale.** Lane, D.C.; Clark, J.A.; Evans, R.J.; Haller, R.A. Western Research Inst., Laramie, WY (USA). Dec 1987. 22p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000498. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Retorting of oil shale, a process which has been of considerable interest during periods of oil supply shortages, produces large amounts of spent shale. A knowledge of the nature of organic materials derived from the oil shale retorting processes and from the spent shale itself is important for assessing impacts on people and the environment. The purpose of the present study is to identify appropriate methods for sampling and characterizing volatile organic components of spent shale and to test the methods on samples of pyrolyzed and combusted oil shale. Volatile organic compounds, (VOCs) in spent shale were obtained by heating a spent shale sample while sweeping the sample with helium. The VOCs in the helium stream were collected on Tenax traps and subsequently analyzed by gas chromatography/mass spectrometry (GC/MS). Collecting the organic components on Tenax traps concentrates the organic constituents and thereby increases the sensitivity of the analytical procedure. Identification of the organic components was accomplished through the use of GC retention time data, library searches carried out on mass spectra, and the interpretation of mass spectra not identified by library searches. The spent shale samples were obtained from a two-stage, pyrolysis and combustion retorting process. 7 refs., 7 figs., 7 tabs.

0406 Products and By-Products

50539 (CHOA–89304ACC0387, pp. 1-14) **Cold Lake oily sand road application practices.** Price, D.H. (Esso Resources Canada Ltd., Calgary, AB (Canada)); Holland, L.L. Canadian Heavy Oil Association (Canada). [1989]. (CONF-8911238–: Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association, Calgary (Canada), 14 Nov 1989; CE–03151). In *Heavy oil production and the environment.* vp. Source: Canadian Heavy Oil Association, 425, 808-4 Avenue S.W., Calgary, AB, CAN T2P 3E8. Prices: $35.00 CAN.

Sand is produced with the bitumen at the Esso Resources Canada Cold Lake cyclic steam stimulation project. This sand accumulates in surface vessels and tanks and is transferred to storage pits. In the pits the sand is prepared for use as a road surfacing material, then applied to the roads. It has been shown that use of the oil sand byproduct as a road surface material can result in a high quality, all weather, durable road surface capable of handling traffic exceeding 400 vehicles/day and loads up to 35 tonnes axle weight. The road surface is not an environmental hazard and is reclaimable with existing technology. The road surfacing methods use commonly available road building and maintenance equipment, and adapt techniques used for laying asphalt to achieve a road surface which approaches asphalt in appearance and performance closely. Gravel addition to the oil sand is a key ingredient for road durability. Proper road surface compaction is essential for road longevity. Oily sand road surfacing operations can occur May through September, during dry weather. Control of moisture content in the road mix will extend the time available for road application within this weather window, and will also lower road surfacing costs. Esso Resources' current oily sand road surfacing costs are in the order

of $1000/km. Oily sand byproduct handling costs, including road surfacing, cost about $70 per cubic meter. 2 figs., 1 tab.

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50535

50540 (CIM/PS–CE03174, pp. 83.1-83.5, Paper 88-39-83) **Hydrocarbon recovery research: Doing more with less through research partnerships.** Plessis, M.P. du (Alberta Research Council, AB (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03174). In *Applied vision: Realizing our potential: Volume 2.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

In western Canada, there is a strong interest in in situ production of heavy oil including conventional heavy crudes and bitumen. Lower world crude oil prices have increased the need for research aimed at reducing production costs and improving recoveries from existing operations in high quality reservoirs as well as from future lower quality reserves. Greater dependence on research to remain competitive at reduced profit margins and reduced funds for research and development have challenged research managers to do more with less. This paper describes how the Oil Sands and Hydrocarbon Recovery Department at the Alberta Research Council is facing this challenge by working in partnership with industry, universities and other research organizations on a variety of projects. These programs include cost-shared programs on process flow mechanisms, development of processes and injection strategies to modify and control conformance in reservoirs, and heat transfer mechanisms in thermal recovery; joint research ventures with industry examining seismic methods for detecting and monitoring miscible displacement fronts in deep reservoirs; partnership projects investigating tailings sludge from mined oil sand plants and developing computer models for energy policy planning and economic evaluations; and contract programs on process evaluation and development, production research, and analytical methods. Collaboration with other research centers is also briefly outlined.

50541 (ST–90-43) **Alberta oil sands annual statistics, 1989.** Energy Resources Conservation Board, Calgary, AB (Canada). Apr 1990. 30p. (CE–03149). Source: Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: $30.00 CAN.

Annual and historical statistics are presented for production, supply, disposition, and processing of oil sands and related products at the Suncor and Syncrude plants in Alberta. The data for 1989 are shown on a monthly basis and include supply and disposition of synthetic crude oil, other hydrocarbons, coke, sulphur, bitumen, and distillate. Similar information is given in the historical section on a yearly basis back to 1979, plus a total for 1967-1980. 13 tabs.

0409 Waste Management

Refer also to citation(s) 50534

50542 (NRC–29895, pp. 598) **Removal of total dissolved solids from oilfield produced water using electrodialysis.** Kok, S. (Environmental Canada, Burlington, ON (Canada)); Zaidi, S.A.; Costa, M. National Research Council of Canada, Ottawa, ON (Canada). [1990]. (CONF-8806495–: Symposium on advances in reverse osmosis and ultrafiltration, Toronto (Canada), 7-10 Jun 1988; CE–03179). In *Advances in reverse osmosis and ultrafiltration.* 29p. Source: Canada Institute for Scientific and Technical Information, Montreal Rd., Ottawa, ON, CAN K1A 0R6. Prices: PRICES UPON REQUEST.

1989.

Some waters produced during the in situ recovery of heavy oil and bitumen contain total dissolved solids (TDS) at concentrations substantially above 8,000 mg/L. This type of produced water cannot be recycled for steam generation in conventional once-through steam generators unless it is treated to remove the dissolved solids. Based on an economic and technical evaluation of TDS removal processes, (evaporation, membrane processes and freeze desalination), electrodialysis was found to be economically attractive under certain conditions. Subsequently, a bench scale study was conducted to evaluate the feasibility of removing TDS from produced waters using electrodialysis and to develop design and cost data for a full scale electrodialysis system. It was concluded that the electrodialysis process is technically feasible for the removal of TDS from high TDS produced waters. It appears that the electrodialysis process would be competitive with vapour compression evaporation for the production of steam generator feed from high TDS produced waters. However, membrane fouling and the performance of the membrane and system components under high temperature (60 to 80°C) operation need to be evaluated through substantially longer term tests than were used during this study. 7 refs., 5 fig., 9 tabs.

0410 Environmental Aspects

Refer also to citation(s) 50534, 51688

50543 (CHOA–89304ACC0387, pp. 1-23) **Evaluation of wildlife interactions with above-ground pipelines.** Young, D.A. Canadian Heavy Oil Association (Canada). [1989]. (CONF-8911238–: Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association, Calgary (Canada), 14 Nov 1989; CE–03151). In *Heavy oil production and the environment.* vp. Source: Canadian Heavy Oil Association, 425, 808-4 Avenue S.W., Calgary, AB, CAN T2P 3E8. Prices: $35.00 CAN.

Concerns are often expressed about above-ground pipelines impeding movements of wildlife, particularly ungulates such as moose and caribou. In response to some of those concerns, research was undertaken to evaluate ungulate interactions with an above-ground pipeline network at an oil sands production facility in northeastern Alberta. The study revealed that the reaction of ungulates to the pipelines was dependent upon the species involved, activity on the pipeline right-of-way and structures on the right-of-way (ROW). Moose and deer are not reluctant to enter ROW's but successful crossings of those ROW's can be affected by a variety of factors, including the presence of above-ground pipelines. Moose tend to step over low pipelines and cross under high pipelines; at intermediate heights moose will turn back (deflect) from crossing the pipeline. Deer displayed a strong trend toward crossing under pipeline. From the findings of this study and results from other investigations, it would appear that providing under-pipe clearances of at least 1.8 m would facilitate successful pipeline crossings by both moose and deer. Existing pipelines could be retrofitted by excavating under pipe. Ramps over pipelines could also be considered. Various other recommendations such as leaving openings in snow-ploughed berms are suggested to facilitate ungulate crossings of corridors. 29 refs., 3 figs.

50544 (SC–011850) **Application to the Alberta Energy Resources Conservation Board for expansion of the Syncrude Canada Ltd. Mildred Lake plant.** Syncrude Canada Ltd., Edmonton, AB (Canada). 27 Apr 1987. vp. (CE–03152). Source: Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: PRICES UPON REQUEST.

An application was made for expansion of an Alberta oil sand plant which would increase saleable hydrocarbon production capacity by 50% to 89.1 Mbbl/y. Capital cost of the project, whose construction phase will extend from 1990 to 1996, is estimated at $3.9 billion. Approval of new extended oil sand mining areas to the north and the east of currently approved mining areas was also requested. Other requests in the application included a new oil sands extraction plant and additional capacity for primary upgrading, hydrotreating, hydrogen production, water treatment, sulfur recovery, and product storage. The increase in production would not result in sulfur emissions above those which are currently approved, and sulfur emissions per barrel of bitumen upgraded would be lower. Included with this application are detailed assessments of the environmental and socio-economic impacts of the expansion project. The most significant environmental impact will be the clearing of 14,545 hectares of land of primarily low value for forestry, wildlife

habitat, or recreational use, for mine expasion and waste disposal. Vegetation loss will be mitigated through staged clearing and reclamation, and local water quality will be ensured by proper drainage measures. Major regional socio-economic impacts include increased volumes of traffic, more demand for outdoor recreational facilities, a need for additional housing and other social infrastructures, and an expanded economic base in the Fort McMurray area. Direct monetary effects of the project to Alberta and Canada are estimated at $15.4 billion and $20.4 billion respectively. 176 refs., 65 figs., 59 tabs.

05 NUCLEAR FUELS

0501 Reserves, Exploration, and Mining

Refer also to citation(s) 51092

0505 Uranium Enrichment

50545 (CONF-9007106–73) **Spreadsheet analysis of gamma spectra for nuclear material measurements.** Mosby, W.R.; Pace, D.M. Argonne National Lab., Idaho Falls, ID (USA). [1990]. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Institute of nuclear materials management conference; Los Angeles, CA (USA); 15-18 Jul 1990. Order Number DE90017824. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A widely available commercial spreadsheet package for personal computers is used to calculate gamma spectra peak areas using both region of interest and peak fitting methods. The gamma peak areas obtained are used for uranium enrichment assays and for isotopic analyses of mixtures of transuranics. The use of spreadsheet software with an internal processing language allows automation of routine analysis procedures increasing ease of use and reducing processing errors while providing great flexibility in addressing unusual measurement problems. 4 refs., 9 figs.

50546 (K/ITP–354) **Report of foreign travel: Training course on enrichment plant safeguards, Luxembourg, June 18–22, 1990.** Cooley, J.N.; Swindle, D.W. Jr. Oak Ridge Gaseous Diffusion Plant, TN (USA). Aug 1990. 117p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90017159. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

During the period of June 13–23, 1990, J. N. Cooley, manager, Safeguards Studies Department International Technology Programs Division, and D. W. Swindle, Jr., director, Technical Integration, Environmental Restoration Division, Martin Marietta Energy Systems, Inc., traveled to Luxembourg City, Luxembourg, to conduct a 5-day uranium enrichment plant safeguards training course for the European Atomic Energy Community (Euratom) Safeguards Directorate. The course is designed to train safeguards professionals, responsible for safeguarding nuclear material at enrichment plants, on the safeguards-relevant principles of enrichment technology. Because Euratom inspects both centrifuge and gaseous diffusion enrichment plants, the course material was revised and expanded to include safeguards principles for both enrichment technologies. The main objective of the course is to provide the course participants with the necessary skills to perform their inspection activities at enrichment plants. 7 refs.

50547 (K/QT–308) **Transient model of an intermediate surge system for the Paducah Gaseous Diffusion Plant.** Beard, B.; Blankenship, J.G.; McGrady, P.W. Oak Ridge Gaseous Diffusion Plant, TN (USA). Sep 1989. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90016000. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Engineering design work (Reference 1) is underway for intermediate surge systems to be added to the Paducah Gaseous Diffusion Plant (PGDP) cascade as part of the Process Inventory Control System (PICS) project. These systems would be located between 000 buildings and lower half 00 buildings and would remove or add inventory during cascade transients in order to protect cascade compressors from overload and surge. Similar systems were operated in the Oak Ridge Gaseous Diffusion Plant cascade and are operated in the Portsmouth Gaseous Diffusion Plant cascade. A steady state flow analysis of the system to be installed at the PGDP has been made. The flow analysis did not address response of the surge system to the cascade transients, nor did it address automatic control of the system. The need to address these issues prompted development of the transient model described in this report. 2 refs., 8 figs., 2 tabs.

50548 (ORNL/tr–90/18) **A continuous three-step resonance photoexcitation photochemical process for the separation of uranium isotopes.** Baoyu, Hsu (Fudan Univ., Shanghai, SH (China)). Oak Ridge National Lab., TN (USA). 1990. 15p. Translation of Chinese Patent Application No. CN 87 1 01066 A. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000882. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A continuous three-step resonance photoexcitation photochemical process used to isolate uranium isotopes is described. The process involves the isolation of uranyl formate monohydrate crystal molecules under non-gas-phase conditions. The uranium isotope was isolated via photochemical reactions produced by the three-step resonance photoexcitation process. Since every photoexcitation step has its own specific selectivity, the overall selectivity, which is the product of the selectivity of each of the above three steps, ends up being very high. Existing spectrum data indicate that the overall selectivity could approach 100%. If this process is used to isolate uranium isotopes, [···]" naturally occurring uranium (which contains about 0.7% U-235) could be extracted as a highly enriched species of uranium (75% or higher). It is clear that this isolation procedure will considerably reduce the cost of uranium enrichment.

50549 (UCRL-CR–104249) **[Technique for determining the static polarizabilities of refractory metal atoms]: Final report.** Bonin, K.D. (Princeton Univ., NJ (USA). Dept. of Physics); Happer, W. Lawrence Livermore National Lab., CA (USA); Princeton Univ., NJ (USA). Dept. of Physics. 15 May 1990. 26p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-48. Order Number DE90017088. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have been working on the development of a technique for determining the static polarizabilities of refractory metal atoms. The technique involves producing a dense, cold atomic beam ($n \simeq 10^{11} - 10^{12}$ atoms/cm^3, $T \perp \simeq 5$ mK) that is illuminated for a short time by a standing wave formed by a Nd:YAG laser. This technique would have an impact on laser isotope separation, ion mobility physics, and theoretical atomic physics. The interaction between the atoms and the laser light results in velocity kicks to the atoms along the two directions defined by the photons in the laser standing wave. The velocity kicks force the atoms to form into planes of alternating high and low density downstream. By Bragg scattering near-resonant light off these planes the static polarizability can be determined. The velocity kicks will also cause the atomic density distribution further downstream to take on a bimodal appearance. A measurement of the separation of the peaks of this distribution can be used to determine the polarizability. Here we report our progress on this technique and the present status of the experiments. A new method for producing focused beams of neutrals, ions, and clusters using two-stage laser ablation has been developed as a result of our experiments. 7 refs., 12 figs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 51121, 51288, 51388

50550 (CEA-CONF–10068) **New strategy for minor actinides partitioning preliminary results on the electrovolatilization of ruthenium and on the stabilization of Am(IV) in nitric acid with phosphotunsgstate ligand.** Adnet, J.M.; Madic, C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif. 1989. 28p. (CONF-8910465–: Workshop on the Partitioning and Transmutation of Minor Actinides, Karlsruhe, DE (USA), 16-18 Oct 1989). Order Number DE91709419. Source: NTIS (US Sales Only), PC A03/MF A01.

On problems related to the long term storage in deep geological repositories of high active wastes (H.A.W.) is due to the presence of minor actinide isotopes. After the decay of fission products (≃ 300 years) toxicity of these H.A.W. is mainly due to the minor actinides. One solution is actinide partitioning followed by transmutation into fission products with short half-lives. A simpler processes than those developed previously, can be based on the possible oxidation of minor actinides to the + IV or + VI oxidation states and their selective extraction. The first step to study is the elimination of ruthenium (whose presence would be detrimental to oxidize minor actinides) which can be done by electrovolatilization of Ru on the RuO_4 form. The rate of electrovolatilization can be increased by the use of the following electronic mediators, AgI/AgII(1); CeIII/Ce(2), and CoII/CoIII(3), efficiency of which decreases in the order: 1 > 2 > 3. The effectiveness of that process has been proven when treating real H.A.W solution produced during the study of reprocessing of a MOX fuel irradiated to as burn-up of 52 GWd/t in a LWR: complete Ru removal was obtained. The second part of the study concerns the electrochemical oxidation of AmIII in nitric acid solutions in the presence of a strong complexing agent: $P_2W_{17}O_{61}K_{10}$ (P.W.).Total americium oxidation to AmIV can be obtained in nitric acid solution with a concentration up to 8 M. No particular drawback was induced by the presence of an amount of lanthanide III (NdIII) in 6 fold excess vs P.W. The stability of AmIV was studied. Other actinides will be present in these solutions, after the electrochemical oxidation step, in the + VI or+ IV oxidation states, thus a selective extraction (vs fission products) could be performed. A possible way to extract actinide IV/P.W complexes is to use dodecylamine nitrate as extractant.

50551 (CEA-CONF–10069) **Results and prospects for some actinide extractants usable in actinide partitioning.** Musikas, C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif. 1989. 18p. (CONF-8910465–: Workshop on the Partitioning and Transmutation of Minor Actinides, Karlsruhe, DE (USA), 16-18 Oct 1989). Order Number DE91709418. Source: NTIS (US Sales Only), PC A03/MF A01.

This paper deals with the results and the prospects of some extractants which could be used for minor actinide partitioning. The main aim of these new extractants is to replace the well-known organophosphorus molecules by completely incinerable molecules. Good candidates are the diamides. The influence of different substituents on the distribution coefficient of Am is investigated, the best extractants possess one short group. The distribution coefficient of Am^3 as a function of the acidity is determined. The extraction by diamides is very good for hexavalent or tetravalent actinides. For Zr the extraction is quite good but the addition of small amounts of oxalic acid decreases the distribution coefficient. The evolution of the distribution coefficient for different actinides as function of the dose rate and HNO_3 concentration is shown. The behaviour of the diamides is the same as that of CMPO. Nitrogen or sulfur donors are suitable for the trivalent actinide-lanthanide group separation.

50552 (CONF-901101–34) **Remote maintenance "lessons learned" on prototypical reprocessing equipment.** Kring, C.T.; Schrock, S.L. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From American Nuclear Society winter meeting; Washington, DC (USA); 11-15 Nov 1990. Order Number DE91000715. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Hardware representative of essentially every major equipment item necessary for reprocessing breeder reactor nuclear fuel has been installed and tested for remote maintainability. This testing took place in a cold mock-up of a remotely maintained hot cell operated by the Consolidated Fuel Reprocessing Program (CFRP) within the Fuel Recycle Division at Oak Ridge National Laboratory (ORNL). The reprocessing equipment tested included a Disassembly System, a Shear System, a Dissolver System, an Automated Sampler System, removable Equipment Racks on which various chemical process equipment items were mounted, and an advanced servomanipulator (ASM). These equipment items were disassembled and reassembled remotely by using the remote handling systems that are available within the cold mock-up area. This paper summarizes the "lessons learned" as a result of the numerous maintenance activities associated with each of these equipment items. 4 refs., 3 figs., 1 tab.

50553 (LA–11839-MS) **Measurement uncertainty estimates for reprocessing facilities.** Gutmacher, R.G. Los Alamos National Lab., NM (USA). Oct 1990. 72p. Sponsored by U.S. Department of Defense; U.S. DOE Nuclear Energy; Nuclear Regulatory Commission. DOE Contract W-7405-ENG-36. Order Number DE90017853. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The present report attempts to provide realistic estimates of measurement uncertainties in reprocessing facilities from an in-depth search of the literature. These estimates were critically selected as meeting the twin criteria of being technically defensible and being derived from actual plant experience under routine operating conditions. Measurements included in the bibliography include volume, weight, density, the concentrations of plutonium and uranium, and their isotopic compositions. The items measured include input (dissolver) solutions, product solutions and oxides, leached hulls, and in-process inventory. In addition to the conventional measurement techniques, we have included certain new ones that have shown enough promise to warrant their inclusion in future reprocessing facilities. The measurement uncertainty estimates given for these new techniques were the estimates obtained when the techniques were applied to the measurement of reprocessing plant items. For a few of the widely used conventional methods, we have included measurement uncertainty estimates that reflect the "state of the art" in order to compare the "state of the art" and "the state of the practice."

50554 **An incinerator ash dissolution model for the system: plutonium oxide, nitric and hydrofluoric acids.** Brown, E.V. (Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering); Tedder, D.W.; Gray, L.W. *Nuclear Technology (USA)*, 89(3): 328-340 (Mar 1990). DOE Contract AC09-76SR00001.

A computer model of an air-lift dissolver was developed to predict the dissolution rates for plutonium oxide (PuO_2), dysprosium oxide (Dy_2O_3), and incinerator ash. This model combines surface kinetics with mass transfer effects to obtain overall rate expressions. The mass transfer coefficients are related to several major process variables. These predictions were compared with experimental tests at Savannah River Laboratory using simulated ash and Dy_2O_3 as a surrogate for refractory PuO_2. The present version of the model over estimates the residual fluoride concentrations in dissolver effluents by ≈50% for several reasons, which are discussed. The minimum air sparge rates to achieve liquid circulation in the dissolver are predicted quite well, within ±6%. The nonvolatile dissolved solids are estimated to within ±5 to 20%.

0509 Transport, Handling, and Storage

50555 (POEF–2046) **Proceedings of the 21PF-1 overpack conference.** Kovac, F.M. (comp.). Martin Marietta Energy Systems, Inc., Piketon, OH (USA). Aug 1990. 144p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-76OR00001. (CONF-8911225–: 21PF-1 overpack conference, Piketon, OH (USA), 14-15 Nov 1989). Order Number DE90017532. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

A conference on the 21PF-1 overpack was held November 14–15, 1989. Topics of discussion included: DOE concerns for the DOT Specification 21PF-1 overpack; UF_6 packaging and transportation chronology; sources of damage, inspection and repair requirements; modifications to 21PF-1 overpacks; and 21PF-1 overpacks thermal analysis and insulation thermal properties.

50556 (WHC-SP–0590-Rev.1) **KE/KW Operations Standardization and Water System Upgrades Program: Program plan: Revision 1.** Lamm, L.W. Westinghouse Hanford Co., Richland, WA (USA). Aug 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90017269. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The KE/KW Operations Standardization and Water System Upgrades Program, which has resulted from the restructuring of the K Area Program described in Revision O of this plan, is focused on resolving certain issues related to the 100K Area fuel storage

basins. These issues pertain to: the radiological consequences and potential environmental impact of storing the fuel in the 100 KE fuel storage basin in open canisters (i.e., increasing activity levels in the basin water due to fuel cladding failures which has resulted in a large volume of contaminated water); The effects of corrosion on the service life of the MK I canisters; the effects on the Plutonium Uranium Extraction (PUREX) facility's filtration system of processing fuel from the MARK (MK) I fuel storage canisters currently stored in the 100 KW fuel storage basin; The need for a more reliable and efficient means of providing water for the 100K Area site and KW basin, and for removing the heat from the basin water. This plan provides an overview of the KE/KW Operations Standardization and Water System Upgrades Program. 2 figs.

50557 The role of sensor directed, model-based control in robotic handling of nuclear waste casks and materials. Bennett, P.C. (Sandia National Labs., Albuquerque, NM (USA)). pp. 1000-1005 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC04-76DP00789. (CONF-900406--: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the results from several projects investigating the application of intelligent machine technologies to remote handling of nuclear waste casks and materials. The importance of computer models of the robot, its environment and their interactions is focused upon. Integration of such models into the sensor based control of robot systems results in significant increases in the capabilities of commercial robots by allowing tuning of robot performance to the task.

50558 Differential atmospheric tritium sampler. Griesbach, O.A.; Stencel, J.R. To Dept. of Energy, Washington, DC (USA). USA Patent 4,935,196/A/. 19 Jun 1990. Filed date 2 Oct 1987. USA Patent patents application 7-103,863. Int. Cl. G21C 19/00. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This paper describes an atmospheric tritium sampler. It comprises: a means for providing and containing a carrier gas, the carrier gas comprising a mixture of H_2 and a diluting gas, the H_2 concentration in the carrier gas comprising less than 4 per cent of the mixture; manifold means for drawing in an air sample through an air intake port and the carrier gas through a carrier gas intake port and for exhausting a mixture thereof through an output port, the air sample containing moisture and HT therein; regulating means for metering the flow of carrier gas to the manifold means; a first moisture trap, connected to receive the exhaust from the manifold means, for adsorbing the moisture from the air sample and exhausting the balance of the air sample/carrier gas mixture; combustion chamber means, connected to receive the exhaust from the first moisture trap; a second moisture trap connected to an separate from the combustion chamber means; discharge means for exhausting the balance of the air sample/carrier gas mixture from the second moisture trap into the atmosphere.

50559 Corrosion resistant storage container for radioactive material. Schweitzer, D.G.; Davis, M.S. To Dept. of Energy, Washington, DC (USA). USA Patent 4,935,943/A/. 19 Jun 1990. Filed date 30 Aug 1984. USA Patent patents application 6-645,652. Int. Cl. G21C 19/00. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This paper describes a corrosion resistant, radioactive-waste-material-isolating, long-term storage container for isolating radioactive waste material in a high level waste repository. It comprises: at least three completely sealed corrosion resistant canisters of different relative sizes, the canisters being arranged with all of the smaller canisters encased within and completely surrounded by and sealed within the largest canister. The smallest canister is encased within all of the other canister in the canisters, and spacer means disposed between juxtaposed pairs of the canisters, the spacer means being effective to space the canisters of each of the juxtaposed pairs from one another.

0510 Economic, Industrial, and Business Aspects

50560 (DOE/IG--0288) **Leased office space for the Yucca Mountain Project.** USDOE Office of Inspector General, Washington, DC (USA). Sep 1990. 6p. Sponsored by U.S. DOE Office of Inspector General. Source: OSTI (Free of Charge).

Report to The Secretary.

This audit assessed the Department of Energy Yucca Mountain Project Office's (Project Office) oversight of the Yucca Mountain Project contractor's leasing of office space. To accomplish the audit objective, we interviewed Department of Energy's Nevada Operations Office, Yucca Mountain Project Office, and contractor officials, and reviewed: (1) Department of Energy (Department) policies, procedures, and practices; (2) General Services Administration (GSA) requirements for utilization of federally owned or leased space; and (3) the lease for the Valley Bank Complex, Las Vegas, Nevada. In addition, we analyzed space utilization as of February 1, 1990, for the Yucca Mountain Project and compared the results to the GSA standard. Our examination followed generally accepted government auditing standards for performance audits, including tests of internal controls and compliance with applicable laws and regulations to the extent necessary to satisfy the audit objective. 1 fig.

0520 Waste Management

Refer also to citation(s) 50554, 50637, 50638, 50639, 50640, 50883, 51092, 51192, 51254, 51281, 51496, 51712, 51714, 51715, 51725, 52236, 52608

50561 (ANL--89/24) **Application of the NNWSI [Nevada Nuclear Waste Storage Investigations] unsaturated test method to actinide doped SRL [Savannah River Laboratory] 165 type glass.** Bates, J.K.; Gerding, T.J. Argonne National Lab., IL (USA). Aug 1990. 83p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-31109-ENG-38. Order Number DE91000583. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The results of tests done using the Unsaturated Test Method are presented. These tests, done to determine the suitability of glass in a potential high-level waste repository as developed by the Nevada Nuclear Waste Storage Investigations Project, simulate conditions anticipated for the post-containment phase of the repository when only limited contact between the waste form and water is expected. The reaction of glass occurs via processes that are initiated due to glass/water vapor and glass/liquid water contact. Vapor interaction results in the initiation of an exchange process between water and the more mobile species (alkalis and boron) in the glass. The liquid reaction produces interactions similar to those seen in standard leaching tests, except due to the limited amount of water present and the presence of partially sensitized 304L stainless steel, the formation of reaction products greatly exceeds that found in MCC-1 type leach tests. The effect of sensitized stainless steel on the reaction is to enhance breakdown of the glass matrix thereby increasing the release of the transuranic elements from the glass. However, most of the Pu and Am released is entrained by either the metal components of the test or by the reaction phases, and is not released to solution. 16 refs., 20 figs., 17 tabs.

50562 (BNL--45188) **Analysis and evaluation of a radioactive waste package retrieved from the Farallon Islands 900-meter disposal site.** Colombo, P.; Kendig, M.W. Brookhaven National Lab., Upton, NY (USA). Sep 1990. 65p. Sponsored by Environmental Protection Agency. DOE Contract AC02-76CH00016. Order Number DE91000908. Source: NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The Environmental Protection Agency (EPA) was given a Congressional mandate to develop criteria and regulations governing the ocean disposal of all forms of waste. The EPA taken an active role both nationally and within the international nuclear regulatory community to develop the effective controls necessary to protect the health and safety of man and the marine environment. The EPA Office of Radiation Programs (ORP) first initiated feasibility studies to determine whether current technologies could be applied toward determining the fate of radioactive waste disposed of in the past. After successfully locating actual radioactive waste packages

in formerly used disposal sites, in the United States, the Office of Radiation Programs developed an intensive program of site characterization studies to examine biological, chemical and physical characteristics including evaluations of the concentration and distribution of radionuclides within these sites, and has conducted a performance evaluation of past packaging techniques and materials. Brookhaven National Laboratory (BNL) has performed container corrosion and matrix analysis studies on the recovered radioactive waste packages. This report presents the final results of laboratory analyses performed. 17 refs., 40 figs., 7 tabs.

50563 (CONF-901105–10) **Effects of mineralogy on the sorption of strontium and cesium onto Calico Hills tuff.** Meyer, R.E.; Arnold, W.D.; Case, F.I.; O'Kelley, G.D.; Land, J.F. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. From Fall meeting of the Materials Research Society; Boston, MA (USA); 24 Nov - 1 dec 1990. Order Number DE90017760. Source: NTIS, PC A; OSTI; INIS; GPO Dep.

Sorption and desorption measurements were made of strontium and cesium onto clinoptilolite and Calico Hills Tuff. The object was to see whether there was a correlation between sorption of strontium and cesium onto Calico Hills Tuff and the clinoptilolite based on the content of clinoptilolite in the Calico Hills Tuff. If sorption onto Calico Hills Tuff is solely due to the presence of clinoptilolite, then the ratios of the sorption ratios on tuff to those on clinoptilolite at similar conditions should be the weight fraction of the clinoptilolite in the tuff. The experimental evidence showed that the ratios were generally near 0.5 for both cesium and strontium sorption and that ion-exchange processes were operative for the clinoptilolite and the tuff. However, the ratios differed to a small extent for different conditions, and there were indications that other sorption processes were also involved. 7 refs., 7 figs., 2 tabs.

50564 (CONF-9010166–4-Vugraphs) **Design and construction of the Interim Waste Management Facility: SWSA 6.** Van Hoesen, S.D. (Oak Ridge National Lab., TN (USA)); Miller, R.A.; Williams, L.C.; Yee, W.C.; Bauman, J.C. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From 6. annual Department of Energy model conference on waste management and environmental restoration; Oak Ridge, TN (USA); 29 Oct - 2 nov 1990. Order Number DE91000710. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Interim Waste Management Facility (IWMF) is planned to provide disposal capacity for solid low-level radioactive waste (LLW) generated at Oak Ridge National Laboratory (ORNL). The LLW generation rate is approximately 30,000 ft^3 per year and consists of a variety of technological wastes, primarily contaminated with short-half life radionuclides. IWMF construction was initiated in May 1990 and operation is expected to begin by September of 1991 and continue through 1996. The performance requirements for the IWMF are established in Department of Energy Order 5820.2a, "Radioactive Waste Management." The IWMF design is based on the concept initially utilized in the Tumulus Disposal Demonstration which has been underway at ORNL since 1986. The tumulus disposal technology involves several elements including: sealing of LLW in structurally stable steel reinforced concrete disposal vaults, stacking of the disposal vaults on grade-level steel reinforced concrete disposal pads, collection and monitoring of storm and infiltrating water which contacts the disposal vaults, placement of low-permeability multi-layer caps over the waste stack, and monitoring of near surface and groundwater. Details of the IWMF site and design are provided in this report. 6 figs.

50565 (DOE/NBM–1070) **Solid Waste Projection Model system overview.** Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 8p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. (PNL–7352). Order Number DE91000017. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The report is an overview of the Solid Waste Projection Model System. Waste management is becoming an increasingly important topic. Management of current and future solid wastes will require the development of appropriate treatment, storage, and disposal (TSD) facilities and operations to match the characteristics of the wastes. Inadequate provision of these TSD facilities and operations will surely incur costs in the form of agency fines or excessive handling fees and may even result in the need to curtail operations. The Solid Waste Projection Model (SWPM) system is an analysis tool developed by Pacific Northwest Laboratory for Westinghouse Hanford Company specifically to address these issues. SWPM provides the ability to develop detailed projections of the volumes of wastes to be managed and the characteristics of these wastes, characterize and evaluate the impact of alternative TSD technologies on facilities and operations, assess the impact upon TSD cost and capacity requirements when waste volumes or waste characteristics vary, and track actual versus projected quantities of wastes, evaluating waste volume-reduction activities. 3 figs.

50566 (DOE/NV/10461–T37-Vol.1) **Evaluation of the geologic relations and seismotectonic stability of the Yucca Mountain area, Nevada Nuclear Waste Site Investigation (NNWSI): Final report, January 1, 1987–June 30, 1988: Volume 1.** Nevada Univ., Reno, NV (USA). Center for Neotectonic Studies. Oct 1988. 462p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract FG08-85NV10461. Order Number DE90004746. Source: NTIS, PC A20/MF A01; OSTI; INIS.

This report provides a summary of progress for the project "Evaluation of the Geologic Relations and Seismotectonic Stability of the Yucca Mountain Area, Nevada Nuclear Waste Site Investigation (NNWSI)" for the eighteen month period of January 1, 1987 to June 10, 1988. This final report was preceded by the final report for the initial six month period, July 1, 1986 to December 31, 1986 (submitted on January 25, 1987, and revised in June 1987). The general Task continued to coordinate project activities to meet general deadlines and responsibilities. The central office provided general secretarial support. The activities that were started during the first project period included expansion of the central copying facilities, growth of the central reprint, map, aerial and photograph collections, and some expansion of personal computer capabilities. The research and review accomplishments are mainly under the following tasks: quaternary tectonics, geochemical, mineral deposits, volcanic geology, seismology, tectonics, neotectonics, remote sensing, geotechnical assessments, geotechnical rock mass assessment, basinal studies, and strong ground motion.

50567 (DOE/RL–90-24-Vol.1) **PUREX Storage Tunnels dangerous waste permit application: Volume 1.** USDOE Richland Operations Office, WA (USA). Sep 1990. 217p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE91000563. Source: NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The Hanford Site is operated by the US Department of Energy-Richland Operations Office. The PUREX Storage Tunnels are a storage unit located on the Hanford Site. The unit consists of two earth-covered railroad tunnels that are used for storage of process equipment (some containing dangerous waste) removed from the PUREX Plant. Radioactively contaminated equipment is loaded on railroad cars and remotely transferred into the tunnels for long-term storage. Westinghouse Hanford Company is a major contractor to the US Department of Energy-Richland Operations Office and serves as a co-operator of the PUREX Storage Tunnels, the waste management unit addressed by this permit application. The PUREX Storage Tunnels Dangerous Waste Permit Application (Revision O) consists of both a Part A and Part B permit application and is based on information available as of August 31, 1990. An explanation of the Part A revision submitted with this document is provided at the beginning of the Part A section. In this Part A revision, the PUREX Storage Tunnels have been redesignated as a miscellaneous unit. The Part B consists of 15 chapters addressing the organization and content of the Part B checklist prepared by the Washington State Department of Ecology.

50568 (DOE/RL–90-24-Vol.3) **PUREX Storage Tunnels dangerous waste permit application: Volume 3.** USDOE Richland Operations Office, WA (USA). Sep 1990. 429p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE91000565. Source: NTIS, PC A19/MF A01 - OSTI; GPO Dep.

The Hanford Site is operated by the US Department of Energy-Richland Operations Office. The PUREX Storage Tunnels are a storage unit located on the Hanford Site. The unit consists of two

earth-covered railroad tunnels that are used for storage of process equipment (some containing dangerous waste) removed from the PUREX Plant. Radioactively contaminated equipment is loaded on railroad cars and remotely transferred into the tunnels for long-term storage. Westinghouse Hanford Company is a major contractor to the US Department of Energy-Richland Operations Office and serves as a co-operator of the PUREX Storage Tunnels, the waste management unit addressed by this permit application. This appendix contains Tunnel 1 Construction Specifications, HWS-5638, consisting of 49 pages.

50569 (DOE/RW–0269P-2) **Quarterly report on program cost and schedule, third quarter FY 1990.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). [1990]. 27p. Sponsored by U.S. DOE Radioactive Waste Management. Source: OSTI (Free of Charge).

This report is intended to provide a summary of the cost and schedule performance for the Civilian Radioactive Waste Management Program. Historical and current cost profiles (extracted from final Financial Information System (FIS) reports) are presented for each of the major program elements. Also included in this report is the status of the Nuclear Waste Fund revenues and disbursements. This report includes data through June 1990. 1 fig.

50570 (EUR–12017, pp. 3-14) **The Swedish programme for in-situ testing of high-level waste forms.** Werme, L.O. (Swedish Nuclear Fuel and Waste Management Company, Stockholm, (Sweden)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The experiment configurations used in the Stripa in-situ test program for high-level waste (HLW) glasses are described. Results from in-situ testing of a HLW glass, similar to what is proposed for vitrification in UP2/3 plants at La Hague, are presented and compared with laboratory results for the same glass. The laboratory results for the glass-water system are found to be confirmed by the field data; after an initially high corrosion rate, the rate of attack drops considerably once silica saturation has been reached. This long-term rate was found to be about the same in the laboratory tests and in the in-situ tests. Also for the glass-bentonite-water system, the glass showed the same general behavior in the in-situ tests as in the laboratory experiments, although the results obtained were less conclusive.

50571 (EUR–12017, pp. 15-24) **The high-level radioactive waste (HAW) in-situ test at ASSE - its conception and goals.** Gies, H. (GSF-Institute fur Tieflagerung, Braunschweig (West Germany)); Hinsch, H.; Moenig, J. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The HAW-disposal test is a demonstration and a research & development test utilizing nearly full-size waste canisters with vitrified Cs-137 and Sr-90 as heat and radiation sources in a repository-like setting. It is, however, not intended as an in-situ experiment for testing the glass product of the vitrified waste. The entire test field comprises two separate rooms, A and B, each having four boreholes. The maximum salt temperatures are planned to be 250°C (electric heating) and 250/200/200°C (γ-radiative heating), with essentially the same maximum dose rates for two pairs of boreholes ($\sim 5 \cdot 10^5$ rad/h). The loaded test canisters are now available and do not completely meet the intended specification. Heat loadings as well as dose rates are, for several reasons, lower than planned by about 30%. The designs of the emplacement boreholes in each of the two test rooms are basically the same. For retrievability reasons, all boreholes will have a liner. Gas sampling from the boreholes will mainly be done in the annular regions. A special dosimetry program, as well as an extensive radiolytic effects program, both in situ and laboratory, are under preparation. A special radiation effects study will be performed with dummy canisters located at the top of the canister stacks.

50572 (EUR–12017, pp. 25-37) **The in-situ testing program in the HADES [High Activity Disposal Experimental Site] facility.** Bonne, A.A. (SCK/Centre d'Etudes de l'Energie Nucleaire, Mol (Belgium)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The underground HADES-facility (HADES-URL) is one of the principal investigation tools within the framework of the Belgian research and development program concerning the disposal of radioactive wastes in geological formations. The facility is located within the Boom Clay, which has been identified as a geological formation with favorable characteristics for disposing of radioactive waste. In view of assessing the feasibility and safety of such an option an intensive in-situ experimental and demonstration program has been set up. The various experiments and tests within the HADES-URL are presented here.

50573 (EUR–12017, pp. 38-46) **United States in situ test programs: WIPP [Waste Isolation Pilot Plant] studies.** Lukow, T.E. (Department of Energy, Carlsbad, NM (USA)); Young, B.H. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The United States has been actively conducting in situ experiments in geologic environments for the last decade. These experiments have been designed to help determine the viability of deep geologic disposal as a solution to the nation's nuclear waste problem. Two projects are now the main focus of this work. They are the Waste Isolation Pilot Plant (WIPP), located southeast of Carlsbad, New Mexico, and the Yucca Mountain Site, located north of Las Vegas, Nevada. The WIPP has been designed for permanent disposal of transuranic radioactive waste within a 610 meter thick, 225 million year old salt deposit. An extensive in situ testing program has been ongoing since 1983 and includes rock mechanics, strength of materials, plugging and sealing, permeabilities, porosity, closure, and heated room studies. The Yucca Mountain Site is being designed to permanently store United States high level waste generated by the nuclear power industry and defense programs. Construction has not yet begun at the Yucca Mountain Site, so experiments are in the planning stage. There have been a number of experiments conducted on spent fuel that can be applied to the Yucca Mountain Site, which are discussed within the text of this paper. Many of the rock mechanics, strength of materials, permeability, and porosity studies will be similar to the WIPP experiments; Yucca Mountain, however, is part of 12-13 million year old volcanic tuff and will ultimately dispose of high level heat-producing radioactive waste. Therefore, substantial differences must be accounted for in the experimental programs at each site.

50574 (EUR–12017, pp. 49-66) **WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] international in situ testing program - MIIT [Materials Interface Interactions Tests].** Wicks, G.G. (E. I. du Pont de Nemours and Company, Aiken, SC (USA)); Molecke, M.A. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

On July 22, 1986, the largest and most cooperative international effort directed at in situ testing of simulated nuclear waste glasses was officially begun. This program, called the Materials Interface Interactions Tests (MIIT), involves the underground emplacement of almost 2,000 simulated high-level radioactive waste samples, package components, and geologic samples in the bedded salt site at the Waste Isolation Pilot Plant (WIPP), near Carlsbad, New Mexico. Samples were supplied by researchers in the United States, France, Germany, Canada, Belgium, Japan, and the United Kingdom. Data and sample performance are being assessed and analyzed by laboratories and universities in each of the participating countries and additional nations also. Samples have been retrieved after 0.5, 1, and 2 years of burial with only the 5 year samples still in test. There are hundreds of samples available for study and many analyses are currently in progress. At present, even though only a small portion of all the data available has been obtained and analyzed, important effects and trends are already emerging. An overview of the MIIT program is presented along with a summary of preliminary findings on performance of Savannah River waste glass in WIPP.

50575 (EUR–12017, pp. 67-77) **Technical operations and data collection details of the in situ WIPP [Waste Isolation Pilot Plant] Materials Interface Interactions Test.** Molecke, M.A. (Sandia National Laboratories, Albuquerque, NM (USA)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The WIPP Materials Interface Interaction Tests (MIIT) experiments involve the in situ testing of multiple pineapple-slice shaped samples of simulated (nonradioactive) waste glasses, potential canister and overpack metals, brine, and rock salt in the salt repository environment at WIPP. This series of experiments involves multiple emplacements of various US and foreign glass waste forms (all nonradioactive) in contact with/interacting with several container metals, rock salt, brine, etc., all maintained at approximately 90+/−5°C. The focus of this paper is on the technical aspects and operations of the MIIT experimental program, including assorted repository-relevant observations and experience gathered after more than two years of in situ test operation. As such, this is primarily a descriptive and test operations document; test data are presented in parallel documents.

50576 (EUR–12017, pp. 81-90) **Examination of ultrathin cross sections from R7T7 glass samples after 6 months and 1 year of alteration in the WIPP [Waste Isolation Pilot Plant].** Vernaz, E. (SDHA, Bagnols Sur Ceze (France)); Godon, N. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

Three stacked R7T7 glass slices were subjected to alteration tests for six months and one year at 90°C as part of the WIPP experiments in New Mexico, in contact either with salt from the Salado salt dome or with brine at equilibrium with the natural salt formation. Ultrathin cross sections were taken from the samples to reveal the degree of glass alteration at the glass/brine, glass/salt and glass/glass interfaces. The alteration films were from 4 to 15 μm thick and the thickest films were found at the glass/brine interface. Magnesium in the salt has a major role in the development of the alteration films, and was the principal element in most of the surface layers. No rare earths were observed in the alteration films, suggesting that little or not actinide retention by the surface layer occurs in this environment.

50577 (EUR–12017, pp. 91-105) **Examination of the German borosilicate nuclear waste glass SM513LW11.** Lutze, W. (Hahn-Meitner-Institute, Berlin (West Germany)); Ewing, R.C. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The Materials Interface Interactions Test (MIIT) in situ began in 1986, the purpose being to evaluate waste-form glass corrosion in the repository environment. Samples were exposed to brine solutions at 90°C for 6 months and 1 year in instrumented boreholes at the WIPP (Waste Isolation Pilot Plant) site. A wide variety of waste-form glasses, the HMI (Hahn-Meitner Institute) (PAMELA) borosilicate glass among them, were included in the test. The results of this relatively short-term in situ experiment are compared to results obtained in the laboratory, predictions based on reaction path modeling and the alteration effects seen in naturally altered analogue glasses.

50578 (EUR–12017, pp. 106-114) **Characterization of BNFL [British Nuclear Fuels Ltd] glasses containing simulated high level waste.** Evans, R. (British Nuclear Fuels, Cumbria (England)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

This paper describes the work carried out to date to characterize glass samples containing simulated United Kingdom high level waste which have been subjected to the Materials Interface Interactions Test (MIIT) glass/salt surface/solution interaction tests. This characterization comprises dimensional measurements, optical microscopy of thin sections cut from all relevant surfaces, and a limited amount of scanning electron microscopy and electron microprobe analysis. Significant corrosion of all surfaces has been observed and a number of trends noted; the main crystalline material present appears to be a magnesium lithium silicate. Further studies are now required to confirm the observations made to data.

50579 (EUR–12017, pp. 117-126) **MIIT [Materials Interface Interactions Tests] study and related activity at WASTEF [Waste Safety Testing Facility].** Tashiro, S. (Japan Atomic Energy Research Institute, Ibaraki (Japan)); Mitamura, H.; Kamizono, H.; Sagawa, T.; Matsumoto, S. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The Materials Interface Interactions Tests (MIIT) glass samples have been observed with an optical microscope and a scanning electron microscope. The tentative results reveal a surface layer formed on the glass. The layer contained Mg, Cl, Si and Fe. As the related studies at Waste Safety Testing Facility, continuous-flow leach tests of simulated high-level waste glass forms and leaching of alpha-irradiated glass forms are reviewed. In the former study the relationship between the normalized leach rate of Si and the linear flow rate of 5×10^{-4} to 5×10^{-1} cm/day is discussed, and it is concluded that the leach rate reaches a constant value above the linear flow rate of 1×10^{-1} cm/day. In the latter the results of leaching of irradiated glass forms are shown in connection with alpha disintegration density and beta/gamma irradiation.

50580 (EUR–12017, pp. 127-139) **Elemental profiling by SIMS [secondary ion mass spectrometry] of leached layers in repository tested SRL [Savannah River Laboratory] waste glass.** Lodding, A. (Chalmers Univ. of Technology, Gothenburg (Sweden)); Engstroem, E.U.; Odelius, H. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level*

waste forms under repository conditions. Proceedings. 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

By means of secondary ion mass spectrometry (SIMS), quantitative in-depth concentration profiles of 20 elements were recorded in Savannah River Laboratory (SRL) 165/TDS waste glass after exposure for 6, 12 and 24 months in the Waste Isolation Pilot Plant (WIPP) repository site. The technique, characterized by high sensitivity of element detection and by very good spatial resolution, permits the identification and thickness determination of different leached or precipitated layers from the surface down into the bulk glass. Further, for each element the amount of leached-out or penetrated atoms can be derived from its SIMS profile. The leaching tendencies in brine environment are reported for glass in contact with glass, steel and lead. The rates of growth of the reacted layers are found to be similar to those previously measured for the same SRL glass in the Stripa site. However, in the salt environment of the WIPP site a particular tendency is seen for a precipitation of Mg, Si and B on the glass surface, and the depletion of boron in the glass is much lower compared to storage in the granite repository.

50581 (EUR–12017, pp. 140-151) **Infrared reflection spectroscopy–part of an integrated approach to MIIT [Materials Interface Interactions Test] sample analysis.** Clark, D.E. (Univ. of Florida, Gainesville (USA)); Zoitos, B.K.; Wicks, G.G.; Molen, K.A. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

This paper documents the use of Fourier Transform Infrared Reflection Spectroscopy (FTIRRS) in conjunction with the Materials Interface Interaction Testing program (MIIT). FTIRRS accomplishes two objectives within the MIIT effort. It serves as a preburial quality assurance tool, allowing determination of uniformity of composition and surface finish within a given group of samples. In addition, FTIRRS is being used along with other surface sensitive techniques to assess glass leaching performance. The use of FTIRRS in both capacities is described, and selected pre- and post-burial data are presented.

50582 (EUR–12017, pp. 152-157) **Dissolution behavior of HLW [high-level waste] borosilicate glass.** Harker, A.B. (Rockwell International Science Center, Thousand Oaks, CA (USA)); Flintoff, J.F.; Howitt, D.G. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The reaction products produced in laboratory brine testing and actual salt repository burial of borosilicate glass simulated high-level defense waste (HLW) forms have been examined by scanning electron microscopy (SEM) and energy dispersive x-ray analysis (EDX). The Savannah River Laboratory (SRL) glass samples examined are from the Materials Interface Interactions Test (MIIT) waste burial project and show typical surface hydration layer formation with identifiable solid reaction products ($CaSO_4$, $MgCl_2$, KCl, and mixed silicates-chlorides). The solid products are not uniformly distributed on the reacting surfaces, indicating that nonequilibrium localized saturation phenomena dominate the surface chemistry. Comparisons with laboratory MCC-1 test results reveal the more complex chemistry in the field tests.

50583 (EUR–12017, pp. 158-171) **Correlation of MIIT [Materials Interface Interactions Test] glass and waste glass compositions.** Wicks, G.G. (E. I. du Pont de Nemours and Company, Aiken, SC (USA)); Ramsey, W.G.; Molen, K.A. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

There are fifteen different glass and waste form systems that are included in the Materials Interface Interactions Test (MIIT) program. Although compositions appear to be very diverse, there are similarities that link each of the waste glasses together. By plotting MIIT compositions in terms of leaching behavior, oxide bonding energies and elemental roles that components play in the glass structure, these correlations can be seen. This analysis shows that there are important similarities between the various MIIT waste glass systems used in the Waste Isolation Pilot Plant/Savannah River Laboratory in situ testing program and that overall behavior of each of these systems would be expected to have common features.

50584 (EUR–12017, pp. 175-182) **Surface analysis data from in-situ testing of ferri-silicate TRUW [transuranic waste] glass WG 124 in the WIPP-MIIT [Waste Isolation Pilot Plant-Materials Interface Interaction Test] facility.** Van Iseghem, P. (SCK/CEN, Mol (Belgium)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

Transuranic waste (TRUW) ferri-silicate glass samples corroded for six and twelve months in the MIIT (Materials Interface Interaction Test) facility in the Waste Isolation Pilot Plant (WIPP) site in New Mexico, were investigated by scanning electron microscope-energy dispersive x-ray analysis (SEM-EDXA) and electron microprobe (EMP) x-ray analysis. The corroded glass surfaces present a double structure, consisting of (1) an outer surface (alteration) layer, containing mainly Mg and Cl, several μm thick, and (2) a subsurface (reaction) zone 4 μm (6 months) to 7 μm (12 months) thick, depleted in the glass constituent Na. This subsurface zone is believed to be indicative for the glass dissolution. Additional surface analyses are required to further validate these preliminary conclusions.

50585 (EUR–12017, pp. 183-191) **Observations of surface layers formed on basaltic and borosilicate glass: 6 month and 1 year MIIT [Materials Interface Interaction Test] experiments.** Jercinovic, M.J. (Univ. of New Mexico, Albuquerque (USA)); Kaser, S.; Ewing, R.C. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

This investigation compares surface layers formed on synthetic basaltic glass and borosilicate waste form glass which have been exposed to brine solutions at 90°C for 6 months and 1 year. Precipitates are in all samples, though there is minimum evidence for glass dissolution. Layers formed on basaltic glass consist of Mg-chloride with a clay-like morphology. Layer thickness after 6 months is 5-10 microns; 10-20 microns after 1 year. Amorphous Mg-silicate dominates the surface layers (5-10 microns thick) on borosilicate glass after 6 months, but Mg-chloride is an abundant overgrowth. Mg-silicate is the dominant phase on layers formed after 1 year (10-15 microns thick). The surface layers on both glass types are the result of brine precipitation and are not, strictly speaking, alteration products. Basaltic glass altered naturally in seawater is markedly different from basaltic glass exposed to the repository environment in terms of the alteration products formed. In addition, alteration products formed on borosilicate and basaltic glass in the repository environment are not the same. The use of natural analogues to verify long-term behavior of waste forms in

the repository environment will be difficult when repository conditions (e.g. brine concentrations) are very different from the natural alteration environment.

50586 (EUR–12017, pp. 192-203) **Summary of WIPP [Waste Isolation Pilot Plant] materials interface interactions Test data on metals interactions and leachate brine analyses.** Molecke, M.A. (Sandia National Laboratories, Albuquerque, NM (USA)); Sorensen, N.R.; Krumhansl, J.L. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

Several series of in situ, high-level waste form leaching and waste form-engineered barrier materials interactions tests have been in progress at the Waste Isolation Pilot Plant (WIPP) facility since July 22, 1986. This multi-national effort, the WIPP Materials Interface Interactions Test (MIIT), involves the underground testing of about 1,900 (nonradioactive) waste form, metal, and geologic samples in the bedded salt at the WIPP, near Carlsbad, New Mexico, in the USA. Posttest analyses of metal and brine leachate samples retrieved after 0.5, 1, and 2 years of heated testing are in progress now; available data and interpretations thereof are summarized in this paper. Titanium, Inconel, and copper samples had very little degradation. Stainless steel 304L samples suffered from significant stress corrosion cracking and pitting. Both mild steel A216/WCA and lead samples corroded severely, adding many ions and particulates to solution. Observed trends in brine leachate compositions for many test assemblies are very similar to those measured for control-blank tests and are, therefore, difficult to interpret at this time. Measured pH values are also difficult to interpret. The leachate analyses and associated geochemical evaluations are intended to supplement glass waste form surface studies, and to provide analysts and modelers with supporting information for their interpretations.

50587 (EUR–12017, pp. 204-210) **Monitoring of MIIT [Materials interface interactions Test] glass solution interactions by brine analysis.** Sassoon, R.E. (Catholic Univ. of America, Washington, DC (USA)); Gong, M.; Adel-Hadadi, M.; Brandys, M.; Barkatt, A.; Macedo, P.B. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

Analyses of brine samples taken from borehole Materials Interface Interactions Test (MIIT) No. 8 at the Waste Isolation Pilot Plant (WIPP) site were carried out in order to study the leaching behavior of the brine in this system. The standard addition method was used with the analytical techniques to determine the concentration of the components in the brine. The changes in the concentration of the major components, Na, Mg and K can be explained by reactions of the brine with the rock salt walls of the borehole. From the data obtained for the other components no leaching of the SRL-Y glass discs in the test could be observed. It was however possible to determine an upper limit for leaching of the glass from isotope ratio studies made on Li which yielded a value for the leach rate of lithium from the glass of 0.117 g m^{-2} d^{-1}.

50588 (EUR–12017, pp. 217-228) **Analysis of leachates and of surface features on glass R7T7 after corrosion in a sodium chloride brine.** Mertens, L.A. (Hahn-Meitner-Institute, Berlin (West Germany)); Lutze, W. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The Hahn-Meitner-Institute (HMI) participated in a round robin test to investigate the release of constituents from a nonradioactive, i.e., simulated borosilicate nuclear waste glass, designated R7T7, under hypothetical incidental conditions in different geologic repositories. Experiments carried out at HMI, relate to the part of the test which studies the behavior of the glass in a salt environment. Leachates were analyzed for Si, B, Mo, and Li (compulsory) and for Al, Fe, Mn, Sr, Zn, and Zr (optional). Also, scanning electron microscopy and electron probe microanalysis investigations were carried out.

50589 (EUR–12017, pp. 229-235) **Repository system simulation test surface analysis of SON 68 glass coupons.** Glatz, J.P. (Commission of the European Communities, Karlsruhe (West Germany)); Huber, T. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The aim of the work is to analyze the surface of glass coupons leached in brine and granite water and try to correlate the results with the leach rate values. The analytical techniques used are scanning electron microscopy (SEM), Rutherford backscattering spectroscopy (RBS) and electron microprobe analysis (EMPA). Surface analysis of glass coupons leached in brine and granite water shows a double gel layer after 1 year of leaching. The composition of the inner layer is only slightly changed compared to the bulk glass composition. The outer layer is enriched in Zr, Fe, Ce and Th and depleted in Mo, B, Cs, Sr and Zn. Na and Si show an irregular profile in this layer. The main differences between samples leached in salt and samples leached in granite are observed for Ca (enriched in granite and depleted in salt) and U (enriched in salt and depleted in granite). These results confirm fairly good the values for normalized elemental mass losses, but they are in contradiction to the weight loss values.

50590 (EUR–12017, pp. 236-241) **RSST [Repository system simulation tests] in granite: Additional tests at CEN-Valrho.** Dussossoy, J.L. (DRDD/SDHA, Bagnols Sur Ceze (France)); Vernaz, E.; Charpentier, H.; Juliot, P. Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The Rhone Valley Nuclear Research Center (CEN Valrho) is participating in the Round Robin Test for repository systems simulation with granite. In addition to the compulsory portion of the test (i.e. Si, B, Mo and Li analysis and pH measurement) a number of additional tests were also carried out. These included the following: (a) analysis for Zr, U, Ce and Nd to simulate actinide behavior; (b) scanning transmission electron microscope (STEM) examination of samples leached for 28 and 91 days; (c) secondary ion mass spectrometry (SIMS) examination of a sample leached for 91 days. An investigation of differences in glass corrosion according to the procedure used to prepare the material column is also discussed.

50591 (EUR–12017, pp. 256-257) **Repository systems simulation test (RRT) salt environment: Preliminary conclusions.** Lutze, W. (Hahn-Meitner Institute, Berlin (West Germany)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The most important objective of the Repository Systems Simulation Test was to evaluate the relative performance of glass R7T7 in a simulated salt, clay, and granite repository environment. The preliminary conclusions related to the round robin tests with respect to

the salt environment have been drafted although the full range of data and their evaluation was not available. The test is based on a standardized test procedure. Test results are presented comparing normalized mass loss values as a function of time.

50592 (EUR–12017, pp. 258-261) **The granite option of the repository simulation test: Preliminary conclusions.** Marples, J.A.C. (Harwell Laboratory, Oxfordshire (England)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The most important objective of the Repository Systems Simulation Test was to evaluate the relative performance of glass R7T7 in a simulated salt, clay, and granite repository environment. The granite option of the test was undertaken by ten laboratories. The procedures carried out by all the laboratories were similar although minor differences were noted. Although the data have not been fully analyzed tentative conclusions are presented regarding the granite options.

50593 (EUR–12017, pp. 262-263) **Repository systems simulation test clay option: Preliminary conclusions.** Van Iseghem, P. (SCK/CEN, Mol (Belgium)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. (CONF-8810189–: Commission of European Communities workshop on testing of high level waste forms under repository conditions, Cadarache (France), 17-21 Oct 1988). In *Testing of high-level waste forms under repository conditions. Proceedings.* 292p. Source: OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 22.50.

The most important objective of the Repository Systems Simulation Test was to evaluate the relative performance of a candidate high-level waste glass R7T7 in simulated granite, salt, and clay environments through the application of a common gest procedure. The conclusions presented for the clay option are based on incomplete data, and some experiments are still underway.

50594 (K/ESH–2) **Hazardous and mixed waste generation at the DOE/ORO installations operated by Martin Marietta Energy Systems, Inc., during calendar years 1987 and 1988.** DePaoli, S.M.; Rivera, A.L.; Eisenhower, B.M. Oak Ridge Gaseous Diffusion Plant, TN (USA). Sep 1990. 57p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OT21400 ;AC05-76OR00001. Order Number DE91000136. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A program was known as the Hazardous Waste Development, Demonstration, and Disposal (HAZWDDD) Program and was formed to address several waste management issues with the main objective being to ensure that all Martin Marietta Energy Systems, Inc., (Energy Systems) treatment, storage, and disposal (TSD) needs for hazardous and mixed waste were identified and planned for properly. A data base was developed and maintained which contained information concerning all hazardous and mixed waste generated, stored, treated, and/or disposed at the five Energy Systems instal-lations during CY 1987. This document presents an update of the HAZWDDD data base for CY 1988. Summaries and figures concerning the data are presented in the body of the report, and a breakdown of the individual waste streams is presented in Appendix A. All five installations produce purely hazardous and mixed waste. The gaseous diffusion plants and Y-12 produce mixed waste contaminated primarily with uranium isotopes, while the mixed waste generated at Oak Ridge National Laboratory (ORNL) is contaminated with various radioisotopes. Generation rates of both hazardous and mixed waste are reported, and inventories of mixed waste are discussed. 18 refs., 9 figs., 5 tabs.

50595 (LA-UR–3229) **Application of plasma shield technology to the reduction, treatment, and disposal of hazardous organic and/or mixed wastes with actinide recovery.** Adams, B.T.; Vaughan, L.L.; Joyce, E.L. Jr.; Bieniewski, T.M. Los Alamos National Lab., NM (USA). [1990]. 10p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9010166–3: 6. annual Department of Energy model conference on waste management and environmental restoration, Oak Ridge, TN (USA), 29 Oct - 2 nov 1990). Order Number DE91000221. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Los Alamos research activities are currently directed at the application of the shielded hydrogen plasma torch to the direct production of actinide metals from a UF_6 feedstock. Two broad classes of thermal plasma reactors are currently in widespread use: the direct current (dc) arc jet system and the radio frequency (rf) inductively coupled system. Los Alamos has improved upon the basic rf plasma tube design using the concept of a transformer. The unique feature of the Los Alamos tube is a segmented, cooled, internal radiation shield. The Los Alamos shielded plasma torch routinely achieves temperatures exceeding 10,000 K and electron densities of $10^{16}/cm^3$ when operated continuously at one atmosphere of argon. These highly energetic conditions are sufficient to dissociate most chemical compounds into their constituent atoms. Based upon these characteristics, Los Alamos is currently investigating the application of the shielded plasma torch technology to the destruction of organic and mixed hazardous wastes, as well as the direct production of actinide metals from the halides and oxides, without the cogeneration of contaminated wastes. 5 refs., 4 figs.

50596 (NAGRA-NTB–86-04) **Exploratory borehole Kaisten. Geology - appendix.** Peters, T. (Bern Univ., Mineral.-petrogr. Inst. (Switzerland)); Meyer, A.; Matter, A.; Isenschmid, C.; Ziegler, H.J. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Nov 1989. 62p. (In German). Source: Available from Nagra, CH-5401 Baden, Switzerland.

The Kaisten borehole was the fifth (after Boettstein, Weiach, Riniken and Schafisheim) in Nagra's deep drilling programme in Northern Switzerland. It is located within the community of Kaisten, Canton Aargau, approximately 3 km south-west of Laufenburg railway station. The final depth of the borehole was 1306 m. Drilling began on 13th February 1984, continued up to 27th June 1984 and was carried out almost exclusively using the conventional rotary drilling method. With the exception of a 5.5 m-long section in the Muschelkalk and two shallow centering boreholes, the whole drilled section was cored. From a depth of 321.5 m in the Crystalline, removal of cores was done by wire core drilling. The wide range of field and laboratory investigations carried out included stratigraphic-sedimentological and mineralogical-petrographic programmes, as well as different petrophysical, geochemical and isotope geochemistry investigation. This report is a summary of all data acquired up to the end of December 1986. Beneath a sedimentary cover just 300 m thick, with Muschelkalk at the top and Permian at the base, the Kaisten borehole entered the crystalline basement at a depth of 296.5 m; investigations were carried out down to a depth of 1306 m. (author) 55 figs., 42 tabs.

50597 (NAGRA-NTB–86-04) **Exploratory borehole Kaisten. Geology - text volume.** Peters, T. (Bern Univ., Mineral.-petrogr. Inst. (Switzerland)); Meyer, A.; Matter, A.; Isenschmid, C.; Ziegler, H.J. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Nov 1989. 308p. (In German). Source: Available from Nagra, CH-5401 Baden, Switzerland.

The Kaisten borehole was the fifth (after Boettstein, Weiach, Riniken and Schafisheim) in Nagra's deep drilling programme in Northern Switzerland. It is located within the community of Kaisten, Canton Aargau, approximately 3 km south-west of Laufenburg railway station. The final depth of the borehole was 1306 m. Drilling began on 13th February 1984, continued up to 27th June 1984 and was carried out almost exclusively using the conventional rotary drilling method. With the exception of a 5.5 m-long section in the Muschelkalk and two shallow centering boreholes, the whole drilled section was cored. From a depth of 321.5 m in the Crystalline, removal of cores was done by wire core drilling. The wide range of field and laboratory investigations carried out included stratigraphic-sedimentological and mineralogical-petrographic programmes, as well as different petrophysical, geochemical and isotope geochemistry investigation. This report is a summary of all data acquired up to the end of December 1986. Beneath a sedimentary cover just 300 m thick, with Muschelkalk at the top and Permian at the base, the Kaisten borehole entered the crystalline

basement at a depth of 296.5 m; investigations were carried out down to a depth of 1306 m. (author) 6 tabs., 122 refs.

50598 (NAGRA-NTB–87-18) **Modelling of the groundwater flow at the Wellenberg site.** Huerlimann, W. (Colenco AG, Baden (Switzerland)); Job, D.; Sieber, C. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Mar 1990. 191p. (In German). Source: Available from Nagra, CH-5401 Baden, Switzerland.

In August 1986 the Group for Hydrodynamic Modelling undertook a hydrogeological modelling study of the potential waste repository site at Wellenberg. The main goal of the study was to identify and quantify those hydrogeological conditions within the project area which could be considered relevant to the long term safety of a waste repository. Additional objectives of the study were the identification of factors which could have some bearing on the planned site investigation programme and the layout of the repository would have on the groundwater flow. A site model domain, enclosing a volume of approximately 25 km^3, was defined. The excavations considered include an upper level repository at 550 m NN, and a deep repository at 250 m NN, together with a vertical shaft between the two levels and that part of an access tunnel lying within the host rock. A near field model enclosing a volume of almost 1.2 km^3, and which allows various layouts of the upper repository together with access and location tunnels to be considered, was created separately. In a parametric sensitivity study, 57 cases were calculated using the site model and, on the basis of the results obtained, a further 14 cases were simulated with the near field model. The calculations were performed by the 3-dimensional steady-state finite element program 'FEM301'. The structure of the model is based on the current general understanding of the site geology. The NE-SW striking area of the Valanginien marl, which forms the host rock, lies between the Axen nappe in the south and the limestone of the Drusberg nappe in the north. From this information a conceptual model based on seven hydrogeological units was compiled. (author) 78 figs., 32 tabs., 21 refs.

50599 (NAGRA-NTB–89-23) **Stripa project: site characterization and validation stage 2- preliminary predictions.** Olsson, O. (ABEM AB, Uppsala (Sweden)); Black, J.H.; Gale, J.E.; Holmes, D.C. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). May 1989. 179p. Source: Available from Nagra, CH-5401 Baden, Switzerland.

The Site Characterization and Validation (SCV) Project is designed to assess how well we can characterize a volume of rock prior to use as a repository. The program of work focuses on the validation of the techniques used in site characterization. The SCV Project contains 5 stages of work arranged in two 'cycles' of data-gathering, prediction, and validation. The first stage of work has included drilling of 6 boreholes (N2, N3, N4, W1, W2, and V3) and measurements of geology, fracture characteristics, stress, single borehole geophysical logging, radar, seismics, and hydrogeology. The rock at the SCV site is granite with small lithological variations. Based essentially on radar and seismic results 5 'fracture zones' have been identified, named GA, GB, GC, GH, and GI. They all extend across the entire SCV site. They are basically in two groups (GA, GB, GC, and GH, GI). The first group are aligned N40°E with a dip of 35° to the south. The second group are aligned approximately N10°W dipping 60°E. From the stochastic analysis of the joint data it was possible to identify three main fracture orientation clusters. The orientation of two of these clusters agree roughly with the orientation of the main features. Cluster B has roughly the same orientation as GH and GI, while features GA, GB, and GC have an orientation similar to the more loosely defined cluster C. The orientation of the third cluster (A) is northwest with a dip to northeast. It is found that 94% of all measured hydraulic transmissivity is accounted for by 4% of the tested rock, not all of this 'concentrated' transmissivity is within the major features defined by geophysics. When the hydraulic connections across the site are examined they show that there are several welldefined zones which permit rapid transmission of hydraulic signals. These are essentially from the northeast to the southwest. (author) 72 fig., 21 tab., 33 refs.

50600 (NAGRA-NTB–90-08) **Stripa project: water flow in single rock joints.** Hakami, E. (Luleaa Univ. (Sweden). Div. of Rock Mechanics). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). May 1989. 135p. Source: Available from Nagra, CH-5401 Baden, Switzerland.

To study the hydromechanical properties of single rock joints a technique to make transparent replicas of natural joint surfaces has been developed. Five different joint samples were replicated and studied. The aperture distribution of the joints was obtained through a measurement method provided by the transparent replicas. The principle behind the method is that a water drop with a known volume, which is placed inside a joint, will cover a certain area of the surface depending on the average size of aperture at the actual point. Flow tests were performed on the same joint replicas. The tortuousity of the flow and the velocity along single stream lines were measured using colour injections into the water flow through the joints. The equivalent hydraulic apertures determined from the flow tests were shown to be smaller than the average mechanical apertures. The velocity of the flow varies strongly between different paths over the joint depending on the spatial distribution of the apertures. The degree of matedness between the joint surfaces is an important factor influencing the channeling character of the joints. (author) 94 figs., 6 tabs., 38 refs.

50601 (NUREG/CR–5521) **Use of performance assessment in assessing compliance with the containment requirements in 40 CFR Part 191.** Bonano, E.J. (Sandia National Labs., Albuquerque, NM (USA)); Wahi, K.K. Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management; Sandia National Labs., Albuquerque, NM (USA). Sep 1990. 49p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–90-0127). Source: NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

This report summarizes the role of performance assessment in assessing compliance with the containment requirements in 40 CFR Part 191, the Environmental Protection Agency's Standard for the disposal of spent nuclear fuel, high-level and transuranic radioactive wastes. In 1986, Hunter et al. prepared a similar report (NUREG/CR-4510, SAND86-0121) which provided an overview of the approach to assess compliance with this standard. The present report builds on its predecessor in that it incorporates advances in performance assessment subsequent to Hunter et al.'s report. The main purpose of this report is to serve as a mechanism for transferring to the Nuclear Regulatory Commission (NRC) and its contractors the performance assessment methodologies (PAMs) developed by Sandia National Laboratories (SNL) for high-level radioactive waste repositories. The report starts with a discussion of the requirements in 40 CFR Part 191 and focuses on the containment requirements (Section 191.13). It follows with a discussion of the role of performance assessment and its use in regulatory compliance. The report concludes with a discussion of sources of uncertainty, treatment of uncertainties, and the construction of the complementary cumulative distribution function of summed normalized total releases to the accessible environment for one or more scenarios. Examples are presented of the demonstration of performance assessment methodologies for high-level waste disposal at two hypothetical sites. Consistent with the technology transfer objective, numerous references are made throughout this report to publications related to the SNL PAMs. As such, this is not a stand-alone report and the reader is encouraged to consult those references. 30 refs., 9 figs., 1 tab.

50602 (NUREG/CR–5594) **Radiation degradation in EPICOR-2 ion exchange resins.** McConnell, J.W. Jr.; Johnson, D.A.; Sanders, R.D. Sr. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1990. 36p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2603). Source: NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The Low-Level Waste Data base Development – EPICOR-II Resin/Liner Investigation Program funded by the US Nuclear Regulatory Commission is investigating chemical and physical conditions for organic ion exchange resins contained in several EPICOR-II prefilters. Those prefilters were used during cleanup of contaminated water from the Three Mile Island Nuclear Power Station after the March 1979 accident. The work was performed by EG&G Idaho, Inc. at the Idaho Engineering Laboratory. This is the final report of this task and summarizes results and analyses of three

samplings of ion exchange resins from prefilters PF-8 and -20. Results are compared with baseline data from tests performed on unirradiated resins supplied by Epicor, Inc. to determine the extent of degradation due to the high internal radiation dose received by the organic resins. Results also are compared with those of other researchers. 18 refs., 23 figs., 7 tabs.

50603 (PNL–7413) **A feasibility study of modeling pedogenic carbonates in soils and sediments at the US Department of Energy's Hanford Site.** Hunter, C.R. (Washington State Univ., Pullman, WA (USA)); Busacca, A.J. Pacific Northwest Lab., Richland, WA (USA); Washington State Univ., Pullman, WA (USA). Sep 1990. 50p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE91000063. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This study was conducted for Pacific Northwest Laboratory by Washington State University in support of the US Department of Energy's Protective Barrier and Warning Marker System Development Program. The objective of this study was to determine the feasibility of deriving information about past water movement patterns from Holocene-age soils in the Hanford region, and using mathematical simulation modeling of pedogenic carbonate accumulations in layered sediments as a performance assessment tool for protective barrier development. The pedogenic carbonate models would serve two purposes in barrier performance assessment: to reconstruct Holocene water movement from the distribution of carbonates in layered sediments as an analog of future water movement in protective barriers, and to simulate the feedback effect of carbonate accumulation on soil hydraulic properties and unsaturated recharge in proposed protective barrier designs. The study progressed in three phases. The first phase was a review and interpretation of current literature on pedogenic indicators of water movement. The review focused on pedogenic and lithogenic processes that drive carbonate accumulation in arid land soils and simulation models linking carbonate distribution to soil hydraulic properties, soil water balance, and climate. The second phase of the feasibility study identified issues and limitations associated with applying or modifying existing computer simulation codes or developing a new code. Finally, the utility of proceeding with the project was determined based on an evaluation of issues and limitations in relation to barrier performance criteria. 101 refs., 4 figs.

50604 (PNL–7442) **Solid Waste Projection Model: Model user's guide.** Stiles, D.L.; Crow, V.L. Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE91000004. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

For Westinghouse Hanford Company.

The Solid Waste Projection Model (SWPM) system is an analytical tool developed by Pacific Northwest Laboratory (PNL) for Westinghouse Hanford company (WHC) specifically to address solid waste management issues at the Hanford Central Waste Complex (HCWC). This document, one of six documents supporting the SWPM system, contains a description of the system and instructions for preparing to use SWPM and operating Version 1 of the model. 4 figs., 1 tab.

50605 (RCM–01587/I+II) **Chemical aerosol measurement and analysis in the PAMELA plant in Mol/Belgium. Final report.** Baumgaertner, F.; Petzoldt, O.; Krebs, K. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie; Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Mar 1988. 177p. (In German). Order Number DE91706355. Source: NTIS (US Sales Only), PC A09/MF A01.

Radiochemical and conventional analytical methods were applied in order to determine the following: (1) The relative nuclide source strength and the size spectrum of aerosols in the off-gas of the ceramic melter. The measurements were done using the rod-type aerosol sampler SAPHIR of the Radiochemistry Institute of Munich Technical University (RCM). (2) The efficiency of the various off-gas purification stages. Efficiencies were measured using membrane filters placed at the head-end and back-end of every stage parallel with the off-gas stream (decontamination factor DF = specific radioactivity at head-end divided by specific radioactivity at back-end). (3) The remaining radioactivity that is released into the atmosphere. These measurements were done using a series of gas scrubbers in a branch section of the purified off-gas stream. During the measuring campaigns with low enriched waste concentrate and high enriched waste concentrate, until summer 1987 all in all 104 SAPHIR samples and 61 filter or scrubber samples, respectively, were drawn from the PAMELA off-gas. Tables show the significant results. (orig./HP).

50606 (SAND–88-1203) **Exploratory Shaft Seismic Design Basis Working Group report: Yucca Mountain Project.** Subramanian, C.V. (Sandia National Labs., Albuquerque, NM (USA)); King, J.L.; Perkins, D.M.; Mudd, R.W.; Richardson, A.M.; Calovini, J.C.; Van Eeckhout, E. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 118p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE91000455. Source: NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This report was prepared for the Yucca Mountain Project (YMP), which is managed by the US Department of Energy. The participants in the YMP are investigating the suitability of a site at Yucca Mountain, Nevada, for construction of a repository for high-level radioactive waste. An exploratory shaft facility (ESF) will be constructed to permit site characterization. The major components of the ESF are two shafts that will be used to provide access to the underground test areas for men, utilities, and ventilation. If a repository is constructed at the site, the exploratory shafts will be converted for use as intake ventilation shafts. In the context of both underground nuclear explosions (conducted at the nearby Nevada Test Site) and earthquakes, the report contains discussions of faulting potential at the site, control motions at depth, material properties of the different rock layers relevant to seismic design, the strain tensor for each of the waveforms along the shaft liners, and the method for combining the different strain components along the shaft liners. The report also describes analytic methods, assumptions used to ensure conservatism, and uncertainties in the data. The analyses show that none of the shafts' structures, systems, or components are important to public radiological safety; therefore, the shafts need only be designed to ensure worker safety, and the report recommends seismic design parameters appropriate for this purpose. 31 refs., 5 figs., 6 tabs.

50607 (SAND–88-2511) **COVE 2A benchmarking calculations using LLUVIA.** Hopkins, P.L. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 65p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE91000078. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Benchmarking calculations using the code LLUVIA have been performed in support of the code verification activity (COVE 2A) for the Yucca Mountain Project (YMP). LLUVIA is a program designed for the efficient solution of one-dimensional, steady flow through multiple layers of saturated or partially saturated, fractured, porous media. The benchmarking calculations involve six steady-state and six time-dependent infiltration problems. For the time-dependent analyses, LLUVIA reported only the final steady-state results. This report documents preliminary calculations, resulting code modifications and final calculations for the COVE 2A study. 7 refs., 79 figs., 3 tabs.

50608 (SAND–89-2176) **Progress in validation of structural codes for radioactive waste repository applications in bedded salt.** Munson, D.E. (Sandia National Labs., Albuquerque, NM (USA)); DeVries, K.L. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005117–1: GEOVAL '90, Stockholm (Sweden), 14-17 May 1990). Order Number DE91000456. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Over the last nine years, coordinated activities in laboratory database generation, constitutive model formulation, and numerical code capability development have led to an improved ability of thermal/structural codes to predict the creep deformation of underground rooms in bedded salt deposits. In the last year, these codes have been undergoing preliminary validation against an extensive database collected from the large scale underground structural in situ tests at the Waste Isolation Pilot Plant (WIPP) in Southeastern

New Mexico. This validation exercise has allowed prediction capabilities to be evaluated for accuracy. We present here a summary of the predictive capability and the nature of the in situ database involved in the validation exercise. The WIPP validation exercise has proven to be especially productive. 7 refs., 4 figs., 1 tab.

50609 (SAND–89-2952C) **Waste segregation procedures and benefits.** Fish, J.D.; Massey, C.D.; Ward, S.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900631–5: International conference on pollution prevention: clean technologies and clean products–the environmental challenge of the 1990's, Washington, DC (USA), 10-13 Jun 1990). Order Number DE91000765. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Segregation is a critical first step in handling hazardous and radioactive materials to minimize the generation of regulated wastes. In addition, segregation can significantly reduce the complexity and the total cost of managing waste. Procedures at Sandia National Laboratories, Albuquerque require that wastes be segregated, first, by waste type (acids, solvents, low level radioactive, mixed, classified, etc.). Higher level segregation requirements, currently under development, are aimed at enhancing the possibilities for recovery, recycle and reapplication; reducing waste volumes; reducing waste disposal costs, and facilitating packaging storage, shipping and disposal. 2 tabs.

50610 (SKB-TR–89-20(app.)) **A critical judgement of the SKB evaluation and assessment of the WP-Cave concept as accounted for in SKB Technical Reports 89-20 and 89-26.** Bergman, S.G.A.; Aakesson, B.Aa. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Nov 1989. 21p. (In Swedish). (SKB-TR–89-26(app.)). Order Number DE91604800. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The report is a critical analysis of the conclusions drawn by the Swedish Nuclear Fuel and Waste Management Co about the ultimate spent fuel storage WP-cave.

50611 (SKB-TR–90-02) **Source terms; isolation and radiological consequences of carbon-14 waste in the Swedish SFR repository.** Hesboel, R. (Studsvik Nuclear, Nykoeping (Sweden)); Puigdomenech, I.; Evans, S. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden); Studsvik Nuclear, Nykoeping (Sweden). Jan 1990. 162p. (STUDSVIK-NP–89-104). Order Number DE91604133. Source: NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The source term, isolation capacity, and long-term radiological exposure of ^{14}C from the Swedish underground repository for low and intermediate level waste (SFR) is assessed. The prospective amount of ^{14}C in the repository is assumed to be 5 TBq. Spent ion exchange resins will be the dominant source of ^{14}C. The pore water in the concrete repository is expected to maintain a pH of >10.5 for a period of at least 10^6 y. The cement matrix of the repository will retain most of the $^{14}CO_3^{2-}$ initially present. Bacterial production of CO_2 and CH_4 from degradation of ion-exchange resins and bitumen may contribute to ^{14}C release to the biosphere. However, CH_4 contributes only to a small extent to the overall carbon loss from freshwater ecosystems. The individual doses to local and regional individuals peaked with $5x10^{-3}$ and regional individuals peaked with $5x10^{-3}$ and $8x10^{-4}$ $\mu Sv\ y^{-1}$ respectively at about $2.4x10^4$ years. A total leakage of 8.4 GBq of ^{14}C from the repository will cause a total collective dose commitment of 1.1 manSv or 130 manSv TBq^{-1}. (authors).

50612 (SKN–37) **Modelling of flow and contaminant migration in single rock fractures.** Dahlblom, P.; Joensson, L. National Board for Spent Nuclear Fuel, Stockholm (Sweden). Mar 1990. 75p. Order Number DE91604801. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The report deals with flow and hydrodynamic dispersion of a nonreactive contaminant in a single, irregularly shaped fracture. The main purpose of the report is to describe the basis and development of a computational 'tool' for simulating the aperture geometry of a single fracture and the detailed flow in it. On the basis of this flow information further properties of the fracture can be studied. Some initial application to dispersion of a nonreactive contaminant are thus discussed. The spatial pattern of variation of the fracture aperture is considered as a two-dimensional stochastic process. A method for simulation of such a process is described. The stochastic properties can be chosen arbitrarily. It is assumed that the fracture aperture belongs to a log-normal distribution. For calculation of the flow pattern, the Navier-Stokes equations are simplified to describe low velocity and steady-state flow. These equations, and the continuity equation are integrated in the direction across the fracture plane. A stream function, which describes the integrated flow in the fracture, is defined. A second order partial differential equation, with respect to the stream function, is established and solved by the finite difference method. Isolines for the stream function define boundaries between channels with equal flow rates. The travel time for each channel can be calculated to achieve a measure of the dispersion. The impact of the aperture distribution on the ratio between the mass balance fracture aperture and the cubic law fracture aperture is shown by simple examples. (28 figs., 1 tab., 22 refs.).

50613 (UCRL–15965) **Fabrication development for high-level nuclear waste containers for the tuff repository: Phase 1 final report.** Domian, H.A. (Babcock and Wilcox Co., Lynchburg, VA (USA). Nuclear Power Div.); Holbrook, R.L.; LaCount, D.F. Lawrence Livermore National Lab., CA (USA); Babcock and Wilcox Co., Lynchburg, VA (USA). Nuclear Power Div.; Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div. Sep 1990. 137p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. Order Number DE91000661. Source: NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This final report completes Phase 1 of an engineering study of potential manufacturing processes for the fabrication of containers for the long-term storage of nuclear waste. An extensive literature and industry review was conducted to identify and characterize various processes. A technical specification was prepared using the American Society of Mechanical Engineers Boiler & Pressure Vessel Code (ASME BPVC) to develop the requirements. A complex weighting and evaluation system was devised as a preliminary method to assess the processes. The system takes into account the likelihood and severity of each possible failure mechanism in service and the effects of various processes on the microstructural features. It is concluded that an integral, seamless lower unit of the container made by back extrusion has potential performance advantages but is also very high in cost. A welded construction offers lower cost and may be adequate for the application. Recommendations are made for the processes to be further evaluated in the next phase when mock-up trials will be conducted to address key concerns with various processes and materials before selecting a primary manufacturing process. 43 refs., 26 figs., 34 tabs.

50614 (UCRL-CR–104738) **Development of models for use in the assessment of waste repository performance: Annual progress report, November 1, 1988–September 30, 1989.** Dickson, A.G. (Scripps Institution of Oceanography, San Diego, CA (USA). Marine Physical Lab.); Weare, J.H. Lawrence Livermore National Lab., CA (USA); California Univ., San Diego, CA (USA). 30 Sep 1989. 15p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (UCSD–891118). Order Number DE91000808. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Any repository suitable for the disposal of radioactive waste comprises a combination of various man-made and natural barriers which aim to prevent transfer of the radionuclides from the canister to the external environment. Our group has developed the techniques needed to model the equilibrium chemistry of complex multicomponent rock/water systems over a range of ionic strengths and temperatures. These models, show remarkable agreement with field measurements when applied to natural systems. They have been applied successfully to interpret a variety of geochemical processes: studies of ancient and modern marine evaporite systems, studies of the solar evaporation of seawater studies of mineral formation in lakes and in fluid inclusions. At present our models are limited to the components of the seawater system

(Na^+, Mg^{2+}, Ca^{2+}, H^+, SO_4^{2-}, HCO_3^-, CO_3^{2-}, CO_2), together with the borate species and SiO_2. 2 tabs.

50615 (UCRL-JC–103679) **US DOE-AECL cooperative program for development of high-level radioactive waste container fabrication, closure, and inspection techniques.** Russell, E.W. Lawrence Livermore National Lab., CA (USA). Jun 1990. 4p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-9009110–3: Joint ANS/ASME nuclear engineering conference, Newport, RI (USA), 16-20 Sep 1990). Order Number DE91000257. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE) and Atomic Energy of Canada Limited (AECL) plan to initiate a cooperative research program on development of manufacturing processes for high-level radioactive waste containers. This joint program will benefit both countries in the development of processes for the fabrication, final closure in a hot-cell, and certification of the containers. Program activity objectives can be summarized as follows: to support the selection of suitable container fabrication, final closure, and inspection techniques for the candidate materials and container designs that are under development or are being considered in the US and Canadian repository programs; and to investigate these techniques for alternate materials and/or container designs, to be determined in future optimization studies relating to long-term performance of the waste packages. The program participants will carry out this work in a conditional phased approach, and the scope of work for subsequent years will evolve subject to developments in earlier years. The overall term of this cooperative program is planned to run roughly three years. 5 refs., 2 tabs.

50616 (WHC-EP–0182-27) **Tank farm surveillance and waste status summary report for June 1990.** Hanlon, B.M. Westinghouse Hanford Co., Richland, WA (USA). Sep 1990. 51p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE91000553. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report is Westinghouse Hanford Company's official inventory for radioactive waste stored in the 200 Areas underground tanks at the Hanford Site. Data that depict the status of stored radioactive waste and tank vessel integrity are contained within the report. The intent of the report is to provide data on each of the existing 177 large underground waste storage tanks and 56 smaller catch tanks, and to provide supplemental information regarding tank surveillance anomalies and ongoing investigations. 1 fig., 1 tab.

50617 (WHC-EP–0210-Rev.1) **Waste characterization plan for the Hanford Site single-shell tanks: Revision 1.** Winters, W.I. (Westinghouse Hanford Co., Richland, WA (USA)); Jensen, L.; Sasaki, L.M.; Weiss, R.L.; Keller, J.F.; Schmidt, A.J.; Woodruff, M.G. Westinghouse Hanford Co., Richland, WA (USA). Aug 1990. 300p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE91000296. Source: NTIS, PC A13/MF A01 - OSTI; GPO Dep.

The Waste Characterization Plan for the Hanford Site Single-Shell Tanks (WCP) describes the initial phase of the two-phase plan to characterize the defense wastes stored in single-shell tanks (SST) on the Hanford Site. The WCP represents an all-purpose plan to identify sampling and analysis requirements for regulatory, performance assessment, and technology and process development purposes. Descriptions of SSTs and the wastes are summarized in the WCP. Procedures for sampling and analyzing the waste for chemical, radiochemical, physical, and waste characteristic parameters are described. Rationale for the selection of parameters and for the use of procedures different than standard methods are discussed. Quality assurance and development activities to support this sampling and analysis effort are described in appendices to the WCP. The first phase of the WCP includes a reference sampling plan that will be used to evaluate laboratory systems, estimate sampling and analysis errors, evaluate vertical distribution of key waste components, determine potential bias in results caused by sampling from existing risers, and estimate tank constituent inventories. 32 refs., 13 figs., 23 tabs.

50618 (WHC-EP–0363) **Solid Waste Management Program Plan.** Duncan, D.R. Westinghouse Hanford Co., Richland, WA (USA). Aug 1990. 66p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE91000295. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objective of the Solid Waste Management Program Plan (SWMPP) is to provide a summary level comprehensive approach for the storage, treatment, and disposal of current and future solid waste received at the Hanford Site (from onsite and offsite generators) in a manner compliant with current and evolving regulations and orders (federal, state, and Westinghouse Hanford Company [Westinghouse Hanford]). The Plan also presents activities required for disposal of selected wastes currently in retrievable storage. The SWMPP provides a central focus for the description and control of cost, scope, and schedule of Hanford Site solid waste activities, and provides a vehicle for ready communication of the scope of those activities to onsite and offsite organizations. This Plan represents the most complete description available of Hanford Site Solid Waste Management (SWM) activities and the interfaces between those activities. It will be updated annually to reflect changes in plans due to evolving regulatory requirements and/or the SWM mission. 8 refs., 9 figs., 4 tabs.

50619 (WHC-SA–0649) **An overview of Hanford site waste cleanup.** Merrick, D.L. Westinghouse Hanford Co., Richland, WA (USA). Nov 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-891103–76: Winter meeting of the American Nuclear Society (ANS) and nuclear power and technology exhibit, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE91000299. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Waste cleanup at the Hanford Site involves actions leading to the disposal of all radioactive and hazardous wastes, managed by the Waste Management Program, and the remediation of inactive sites and facilities, managed by the Environmental Restoration Program. The Waste Management Program consists of five missions: double-shell tank wastes, single-shell tank wastes, encapsulated cesium and strontium, solid wastes (SW), and liquid effluents. A general category of program support is also included. The Environmental Restoration Program consists of two missions: past practice units and surplus facilities. An extensive technology research, development, demonstration, testing, and evaluation (RDDT&E) effort is under way. Emphasis is placed on research and development for missions where the technology to be implemented is uncertain, and on demonstration, testing, and evaluation for missions where the technology to be implemented is well developed. 2 figs., 2 tabs.

50620 (WHC-SA–0993) **Reverse osmosis applications to low-level radioactive waste.** Garrett, L. Westinghouse Hanford Co., Richland, WA (USA). Sep 1990. 14p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. (CONF-9010202–1: 8. 1990 annual membrane technology/planning conference and 1. high-tech separations symposium, Newton, MA (USA), 15-17 Oct 1990). Order Number DE91000551. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Hanford Site at Richland, Washington, is operated for the US Department of Energy (DOE) by Westinghouse Hanford Company. Since the Hanford Site was established in the 1940's, the operation of the various facilities has resulted in the contamination of liquid effluents and some groundwater with radioactive constituents. Westinghouse Hanford Company has been testing various technologies to determine their effectiveness in decontaminating these two types of liquids. Reverse osmosis (RO) has been applied to two process effluents and two groundwaters. Rejection data have been collected for uranium, technetium, tritium, strontium, cesium, and total alpha and beta. 4 refs., 1 fig., 8 tabs.

50621 (WSRC-MS–90-153) **Aqueous processing of actinides at Savannah River.** Gray, J.H. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-9005161–4: 14. Gatlinburg actinide separations conference, Gatlinburg, TN (USA), 14-17 May 1990). Order Number DE91000779. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A number of changes affecting the DP-Complex are having an impact on operations at the Savannah River Site (SRS). In order for SRS to continue as a major contributor within the DP-Complex and remain in position to respond to requests based on new initiatives, programs aimed at redirecting the actinide processing activities have been started. One area undergoing process modifications is F-Canyon, where most of the plutonium feedstocks are processed. Programs already underway that are affecting the dissolution of plutonium materials in canyon dissolvers and the purification of aqueous streams in the second plutonium solvent extraction cycle are discussed. Issues influencing program direction involve environmental concerns, waste minimization, health protection, storage limitations, and material recycle. Each of these issues is discussed in relation to operations in F-Canyon and results based on initial development studies are presented.

50622 (WSRC-RP–89-1409) **Establishing the acceptability of Savannah River site waste glass.** Plodinec, M.J.; Kitchen, B.G. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900977–2: Spectrum '90: American Nuclear Society (ANS) international meeting on radioactive waste technologies, decontamination, and hazardous wastes, Knoxville, TN (USA), 30 Sep - 4 oct 1990). Order Number DE91000782. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The United States' first facility to immobilize high-level nuclear waste, the Defense Waste Processing Facility (DWPF), will soon begin integrated nonradioactive testing. An important objective of that testing is to demonstrate that the DWPF product will comply with specifications established by the Department of Energy's Office of Civilian Radioactive Waste Management (RW). In this report, the DWPF process and product are described, and the approach being taken to establish the acceptability of the DWPF product is presented. 8 refs., 2 figs., 1 tab.

50623 **[Nuclear waste containment at Yucca Mountain].** Clark, W.L.; Farmer, J.C.; Halsey, W.G.; McCright, R.D. pp. 437-442 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses nuclear waste containers to be emplaced at Yucca Mountain, which must remain intact for 1,000 years. Stability of the container material is examined. Development of models for predicting long-term material performance is addressed.

50624 **Thermal stability of zeolitic tuff from Yucca Mountain, Nevada.** Bish, D.L. (Earth and Environmental Sciences Div., Los Alamos National Lab., Los Alamos, NM (US)). pp. 596-602 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses thermal models of the potential repository at Yucca Mountain, Nevada, that suggest that rocks near the potential host rock will experience elevated temperatures for at least 1000 yr. The effects of elevated temperatures on zeolitic tuffs, the thermal stabilities of the zeolites clinoptilolite and mordenite, common in the rocks at Yucca Mountain have been investigated. Thermal behavior of both zeolites is presented.

50625 **Geochemical modeling: An integrated approach to nuclear waste disposal issues.** Bruton, C.J. (Lawrence Livermore National Lab., CA (USA)); Viani, B.E.; Bourcier, W.L.; Jackson, K.J.; Aines, R.D. pp. 594-595 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the need for prediction over time periods of up to 100,000 years of factors involved in nuclear waste disposal. Experimental programs are presented. Geochemical modeling codes are addressed.

50626 **Surface-based site characterization testing to determine the suitability of the Yucca Mountain site for a nuclear waste repository.** Hughes, W.T. (U.S. DOE, Yucca Mountain Project Office, Las Vegas, NV (US)); Clanton, U.S. pp. 584-586 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the site characterization of the Yucca Mountain site in Nevada. Its suitability for the first U.S. high-level radioactive waste repository is examined. Regulatory performance criteria are presented.

50627 **Plans for characterization of the potential geologic repository site at Yucca Mountain, Nevada.** Dobson, D.C. (U.S. Dept. of Energy, Las Vegas, NV (US)); Blanchard, M.B.; Voegele, M.D.; Younker, J.L. pp. 580-583 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses planned site characterization for Yucca Mountain. The data acquisition activities are described. Probabilities for catastrophic geologic events are presented.

50628 **Dynamic use of geoscience information to develop scientific understanding for a nuclear waste repository.** Cook, N.G.W. (Lawrence Berkeley Lab., CA (USA). Earth Sciences Div.); Tsang, C.F. pp. 565-571 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC03-76SF00098. (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the development and safety evaluation of a nuclear waste geologic repository. Scientific understanding dependent upon information from a number of geoscience disciplines is described. A discussion is given on the dynamic use of the information through the different stages. The authors point out the need for abstracting, deriving and updating a quantitative spatial and process model (QSPM) to develop a scientific understanding of site responses as a crucial element in the dynamic procedure.

50629 **Study of fractal aperture distribution and flow in fractures.** Kumar, S. (Lawrence Berkeley Lab., CA (USA). Earth Sciences Div.); Zimmerman, R.W.; Bodvarsson, G.S. pp. 559-564 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC03-76SF00098. (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper examines the roughness profiles and aperture distributions of fractures and faults by using concepts from fractal geometry. Simple models of flow of fluid in rough fractures are also discussed. A deterministic fractual representation of the roughness profile is presented which is shown to have many distinct advantages over other numerical methods, such as information compression, uniqueness and repeatability of surface simulation, retention of statistical information, and self-similarity over many scales.

50630 **A stratified percolation model for saturated and unsaturated flow through natural fractures.** Pyrak-Nolte, L.J. (Purdue Univ., Lafayette, IN (USA). Dept. of Earth and Atmospheric Sciences); Cook, N.G.W.; Myer, L.R. pp. 551-558 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC03-76SF00098. (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the geometry of the asperities of contact between the two surfaces of a fracture and of the adjacent void spaces that determines fluid flow through a fracture and the mechanical deformation across a fracture. The authors have developed a stratified continuum percolation model to describe this geometry based on a fractal construction that includes scale in

variance and correlation of void apertures. Relative permeability curves are shown.

50631 Permeability and dispersivity of variable-aperture fracture systems. Tsang, Y.W. (Lawrence Berkeley Lab., CA (USA). Earth Sciences Div.); Tsang, C.F. pp. 544-550 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC03-76SF00098. (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper introduces a new approach in which medium properties, such as the permeability to flow and dispersivity in tracer transport, are correlated on only three statistical parameters describing the fracture aperture probability distribution and the aperture spatial correlation. The authors demonstrate how saturated permeability and relative permeabilities for flow, as well as dispersion for solute transport in fractures may be calculated. They examine the applicability of these concepts to field problems. Results from the evaluation and analysis of the Stripa-3D field data are presented.

50632 Simulation of heat transfer in the unsaturated zone. Zyvoloski, G. (Earth Environmental Sciences Div., Los Alamos National Lab., Los Alamos, New Mexico (US)). pp. 611-617 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the roll of heat transfer in fluid flow near the emplacement site of high-level nuclear waste. Two wells at the Yucca Mountain site are described. Numerical models are presented.

50633 Drill-back studies examine fractured, heated rock. Wollenberg, H.A. (Lawrence Berkeley Lab., CA (USA). Earth Sciences Div.); Flexser, S.; Myer, L.R. pp. 603-610 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC03-76SF00098. (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper investigated the effects of heating on the mineralogical, geochemical, and mechanical properties of rock by high-level radioactive waste. Results of core examinations are reported. Mechanical - property studies are presented.

50634 WIT [Waste Immobilization Technology]: A case study in Waste Immobilization Technology. Kasten, J.L. (Oak Ridge National Laboratory, TN (USA)); Godbee, H.W.; Gilliam, T.M. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 65-68 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

The Waste Immobilization Technology (WIT) Evaluation Program is a subtask of the Low-Level Waste Disposal Development and Demonstration (LLWDDD) Program at the Oak Ridge National Laboratory (ORNL). The ability of these waste forms to meet selected performance criteria was evaluated. This evaluation involved a battery of test protocols to assess the performance characteristics of the waste forms as well as the capability of test protocols to measure performance.

50635 Waste form durability and its relationship to permissible release rates. Godbee, H.W. (Oak Ridge National Laboratory, TN (USA)); Rivera, A.L.; Jolley, R.L.; Kasten, J.L.; Anders, O.U. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 69-72 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Among workers dedicated to the disposal of chemically hazardous and/or radioactive wastes, the generally accepted concept of waste form durability means a waste form that resists physical wear and chemical attack while remaining intact in the disposal site environment for the period of time required for safe disposal. Waste form, in this paper, means the product generated when a mobile waste has been subjected to a stabilization/solidification process. A computer code that incorporates many of the factors which cause deterioration [using both continuous and discontinuous (failure) functions] of concrete in man-made barriers was recently made available by the Electric Power Research Institute.

0530 Environmental Aspects

Refer also to citation(s) 50601, 50611, 50637, 50638, 51603, 51687, 51712, 51764

50636 (BNL–44984) **Bubbler-probe manometry in nuclear process tank measurements.** Suda, S.C. Brookhaven National Lab., Upton, NY (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9007106–71: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90017637. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Bubbler-probe manometry has been used to measure the volume of uranium and plutonium bearing solutions in highly radioactive process tanks for over forty years. The technique involves directing a flow of gas through a submerged probe and measuring the resultant line pressure. The pressure can be expressed as a function of height or weight per unit area of the liquid above the bubbler-probe orifice. Measuring pressure is simple and quick, and high-accuracy level measurements are easily obtained by means of pneumatic scanning techniques and a null-balance, quartz Bourdon-tube, electromanometer. Overall volume uncertainties of less than 0.1% are routinely achieved using a computer-based data-acquisition system that averages the electromanometer response over ten seconds. This paper describes the application of high-accuracy, bubbler-probe manometry to volumetric measurements in process tanks. 12 refs., 6 figs.

0540 Health and Safety

Refer also to citation(s) 50619, 51856, 51881

50637 (CONF-9004181–Vol.1) **Remedial Action Program annual conference: Proceedings: Volume 1, Remedial action under the Environmental Restoration and Waste Management Five-Year Plan.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (USA). Office of Environmental Restoration. [1990]. 651p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. From DOE remedial action under the environmental restoration and waste management five-year plan; Albuquerque, NM (USA); 16-19 Apr 1990. Order Number DE91000103. Source: NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

Within the DOE's Office of Environmental Restoration & Waste Management, the Office of Environmental Restoration manages a number of programs whose purposes are to complete remedial actions at DOE facilities and sites located throughout the United States. The programs include the Surplus Facilities Management Program, the Formerly Utilized Sites Remedial Action Program, the Uranium Mill Tailings Remedial Action Program, and the West Valley Demonstration Project. These programs involve the decontamination and decommissioning of radioactively-contaminated structures and equipment, the disposal of uranium mill tailings, and the cleanup or restoration of soils and ground water that have been contaminated with radioactive or hazardous substances. Each year the DOE and DOE-contractor staff who conduct these programs meet to exchange information and experience in common technical areas. This year's meeting was hosted by the Uranium Mill Tailings Remedial Action Project, DOE-AL, and was held in Albuquerque, NM. This volume of proceedings is the record of that conference. The proceedings consist of abstracts, summaries, or actual text for each presentation made and any visual aids used by the speakers.

50638 (CONF-9004181–Vol.2) **Department of Energy remedial action program annual conference: Proceedings: Volume 2, Remedial action under the environmental restoration and waste management five-year plan.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC

(USA). Office of Environmental Restoration. [1990]. 272p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. From DOE remedial action under the environmental restoration and waste management five-year plan; Albuquerque, NM (USA); 16-19 Apr 1990. Order Number DE91000104. Source: NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

The Office of Environmental Restoration manages a number of programs whose purposes are to complete remedial action at Department of Energy (DOE) facilities and sites located throughout the United States. This volume contains 18 papers on the topics environmental restoration and hazardous/mixed waste characterization and remediation. Individual papers are indexed separately on the Energy Database. (KJD)

50639 (DOE/OR/21548–136) **Addendum to engineering evaluation/cost analysis for the proposed management of 15 nonprocess buildings (15 Series) at the Weldon Spring site chemical plant, Weldon Spring, Missouri.** MacDonell, M.M.; Peterson, J.M. Argonne National Lab., IL (USA). Aug 1990. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548 ;W-31109-ENG-38. Order Number DE90018035. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An engineering evaluation/cost analysis (EE/CA) report was prepared in May 1989 to analyze alternatives for a proposed removal action to manage 15 nonprocess buildings, designated as the 15 Series buildings, at the chemical plant area of the Weldon Spring site. The alternative selected as a result of the analyses was to dismantle the buildings and to salvage or transport off-site for treatment or disposal all nonradioactively contaminated materials and to store on-site in a material staging area (MSA) all radioactively contaminated materials, pending a decision for disposal of all wastes resulting from remediation of the Weldon Spring site. Region VII of the US Environmental Protection Agency (EPA) and the state of Missouri concurred with the selection of this alternative and provided comments on the EE/CA report. The proposed removal action was not initiated at that time due to funding constraints. This addendum has been prepared to update information provided in the EE/CA report, provide additional information on the MSA, and respond to EPA Region VII and state of Missouri comments on the EE/CA. 5 refs., 1 tab.

50640 Three-dimensional plume dynamics in the vadose zone: Porflo-3 modeling of a defense waste leak at Hanford. Smoot, J.L. (Pacific Northwest Lab., Richland, WA (USA)); Sagar, B. pp. 537-543 of High level radioactive waste management: Volume 1. American Nuclear Society, La Grange Park, IL (USA) (1990). pp. 1456 DOE Contract AC06-76RL01830. (CONF-900406–: 1. international topical meeting on high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990).

This paper discusses the leak of liquid containing radioactive and chemical wastes from a single-shell tank into the vadose zone. A plume migration model is presented. Simulated distributions are given.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 50546, 50553

50641 (CONF-9007106–74) **Systems Analysis for Material Control and Accountancy Technology (SAMCAT).** Persiani, P.J., Bucher, R.G.; Rothman, A.B.; Cha, B.K. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Institute of nuclear materials management conference; Los Angeles, CA (USA); 15-18 Jul 1990. Order Number DE90017835. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Systems Analysis for Material Control and Accountancy Technology (SAMCAT) is an interactive computer-based management system developed for the Department of Energy Office of Safeguards and Security, to assist in defining and prioritizing measurement upgrades programs for Material Control and Accountancy (MC&A). The accountancy upgrades options evaluated by SAMCAT in this study are: (1) improvement of the uncertainties in the SNM measurement methods, (2) reduction of throughputs and/or inventories of SNM, and (3) reduction of the material balance accounting period. The goals of the MC&A upgrades program are reduced inventory differences and associated uncertainties, improved detection probabilities for theft/diversion, decreased operating costs, and enhanced material traceability. 6 refs., 3 figs., 2 tabs.

50642 (PNL-SA–18423) **Physical security systems inspection tools and techniques.** Wisdom, G.D. (USDOE Assistant Secretary for Defense Programs, Washington, DC (USA). Office of Security Evaluations); Goodey, K.O. Pacific Northwest Lab., Richland, WA (USA). Jul 1990. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-9007106–67: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90017142. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE), Office of Security Evaluations, has developed a comprehensive inspection guide for physical security systems that can be used by the relatively new or seasoned inspector to enhance the inspection process. At the same time the guide provides some utility for those in the field of physical security systems management and implementation. This guide provides a standard framework for consistent inspections and allows enough flexibility to accommodate widely varying situations and conditions. The guide does not provide a single methodology for accomplishing inspections, but rather offers tools that can be applied at the discretion of the inspector, thereby facilitating better planning, data collection, analysis and report generation. Consistency in structure and format of inspections should minimize difficulties in the management, implementation, and inspection of physical security systems. 3 refs., 3 figs.

50643 (SAND–90-0495) **A view for security: Thermal imagers.** Beckmann, R.C. (Sandia National Labs., Albuquerque, NM (USA)); Pritchard, D.A.; Karst, J. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 14p. Sponsored by U.S. Department of Defense; U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90016690. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The use of thermal imagers in everyday security applications has been, until recently, very limited. The last several years have seen an increased use of existing military inventory and commercial imagers to satisfy a variety of security and surveillance needs. This paper discusses the recent history of applying today's available thermal imagers to security-related problems. It discusses the problems, the deficiencies of existing imagers to solve those problems, and summarizes the current status of imagers applied to security and suggest imager features which would make them more useful to security applications. 2 refs.

50644 (SAND–90-1039) **Stellar Systems Inc. Series 800/5000 E-Field sensor evaluation.** Follis, R.L. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 76p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE91000087. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report concerns the evaluation of the Stellar Systems Inc. E-Field intrusion detection system Series 800 control unit and the 5000 Series hardware components. Included are functional descriptions, installation procedures, testing procedures, and testing/operational results. 35 figs.

50645 (UCRL–97641) **White Paper Panel No. 5 performance evaluation.** Al-Ayat, R.A. Lawrence Livermore National Lab., CA (USA). 12 Nov 1987. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8711348–1: National academy of sciences national research council workshop, Washington, DC (USA), 17-19 Nov 1987). Order Number DE90015905. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Developing performance indicators and framework for evaluating the effectiveness of material control and accountability (MC&A) systems is a difficult and challenging task. Over the years, emphasis has been placed on upgrading physical protection systems at facilities handling special nuclear material (SNM) to protect against external terrorists attack and little attention was directed to the safeguards contributions of MC&A. Focus is now shifting to the insider threat and the need to provide balanced protection against all threats. Achieving this balanced protection, however, requires an

understanding of: (1) the safeguards role of MC&A systems; (2) the trade-off between MC&A and the other safeguards components, namely human reliability programs and physical protection systems; (3) the choice of performance measures; (4) an evaluation framework for assessing MC&A system effectiveness, identifying weaknesses, and setting priorities among upgrades to address these weaknesses; and (5) the standards required for adequate protection. 8 refs., 1 fig.

0560 Legislation and Regulations

Refer also to citation(s) 50601, 50637, 50838

50646 (NEI-SE–60) **New radiation protection legislation in Sweden.** Jender, M. (Ministry of Environment and Energy, Stockholm (Sweden)); Persson, Lars. Consultative Committee for Nuclear Waste Management (KASAM), Stockholm (Sweden). [1984]. 8p. Order Number DE91604864. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Contribution to the Inter Jura 89 conference.

The objective of the new Act is to protect humans, animals and the environment from the harmful effects of ionizing as well as non-ionizing radiation. As previously, the main responsibility for public radiation protection will rest with a single central radiation protection authority. According to the Act, the general obligations with regard to radiation protection will assign greater responsibility than in the past to persons carrying out activities involving radiation. Persons engaged in such activities will be responsible for the safe processing and storage of radioactive waste. The Act also contains rules governing decommissioning of technical equipment capable of generating radiation. The Act contains several rules providing for more effective supervision. The supervisory authority may, in particular, decide on the necessary regulations and prohibitions for each individual case. The scope for using penal provisions has been extended and a rule on the mandatory execution of orders regarding radiation protection measures has been introduced. (authors).

50647 (NEI-SE–61) **Ethical aspects on Nuclear Waste.** Persson, Lars (National Inst. of Radiation Protection, Stockholm (Sweden)). Consultative Committee for Nuclear Waste Management (KASAM), Stockholm (Sweden). [1989]. 11p. Order Number DE91604865. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Contribution to the Inter Jura 89 conference.

In an ethical assessment of how we shall deal with nuclear waste, one of the chief questions that arises is how to initiate action while at the same time taking into consideration uncertainties which are unavoidable seen from a long-term perspective. By means of different formulation and by proceeding from various starting-points, a two edged objective is established vis-a-vis repository facilities: safety in operation combined with reparability, with controls not necessary, but not impossible. Prerequisites for the realization of this objective are the continued advancement of knowledge and refinement of the qualifications required to deal with nuclear waste. The ethical considerations above could be the bases for the future legislation in the field of nuclear energy waste. (author).

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

50648 (UCRL-CR–104873) **Microwave excitation of copper vapor plasmas: Final report.** Brake, M.L. (Michigan Univ., Ann Arbor, MI (USA). Dept. of Nuclear Engineering). Lawrence Livermore National Lab., CA (USA); Michigan Univ., Ann Arbor, MI (USA). Coll. of Engineering. [1990]. 68p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-48. Contract B076262. Order Number DE91000588. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Microwave resonant cavity produced copper vapor plasmas at 2.45 GHz, both pulsed (5 kW, 5kHz,) and CW (0–500 Watts) have been investigated using heated copper chloride as the copper source. The visible emitted light has been observed and intense lines at 510.6 nm and 578.2 nm have also been observed. Initial measurements of the electric field strengths have been taken with probes, the plasma volume has been measured with optical techniques, and the power has been measured with power meters. A self-consistent electromagnetic model of the cavity/plasma systems which uses the above data as input shows that the copper plasma has skin depths around 100 cm, densities around 10^{12}#/cc, collisional frequencies around 10^{11}/sec, and conductivities around 0.15 $(\text{Ohm-meter})^{-1}$. A simple model of the heat transfer predicts temperatures of ~800 K. All of these parameters indicate that microwave discharges may be well suited as a pump source for copper lasers.

0702 Radiation Sources

Refer also to citation(s) 51423, 51496, 52513

50649 (INT–194/I) **Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane.** Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. 132p. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Separate abstracts were prepared for 6 of the papers in this report. The remaining 7 papers were considered outside the subject scope of INIS. (A.S.).

50650 (INT–194/I, pp. 39-46) **Radiotracer methods in industry, environmental protection and hydrology.** Chmielewski, A.G. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)); Bazaniak, Z.; Michalik, J.St. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). In *Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane.* 132p. Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The main directions of research works of Department of Nuclear Methods of Process Engineering of Institute of Nuclear Chemistry and Technology in Warsaw are described. (A.S.).

50651 (INT–194/I, pp. 47-59) **Use of radiotracer methods for determining parameters of pyrometallurgical processes.** Bazaniak, Z. (Institute of Atomic Energy, Otwock-Swierk (Poland)). Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). In *Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane.* 132p. Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The tracer techniques elaborated for pyrometallurgy (technological process of copper production) are shortly described. (L.I.).

50652 (INT–194/I, pp. 61-77) **Complex investigations of copper ores processing.** Petryka, L. (Institute of Physics and Nuclear Techniques, Cracow (Poland)); Stegowski, Z.; Furman, L.; Palacz, K. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). In *Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane.* 132p. Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The system elaborated in the Academy of Mining and Metallurgy in Cracow for carry out radiotracer investigations with simultaneous registration of technological parameters is described. The use of microcomputers enables the calculations and obtaining results during measurements. (A.S.).

50653 The applicaton of neutron radioscopy to lithium-aluminum alloy target elements. Antal, J.J. (Army Materials Technology Lab. (US)); Marotta, A.S.; Salaymeh, S.R.; Varallo, T.P. pp. 62-68 of Proceedings of the seventeenth symposium on nondestructive evaluation. Iddings, F.A.; Moore, D.W. Nondestructive Testing Information Analysis Center, San Antonio, TX (USA) (1989). pp. 347 (CONF-8904358–: 17. symposium on nondestructive evaluation, San Antonio, TX (USA), 17-20 Apr 1989).

The authors show that neutron radioscopy is very useful in locating the position of a Li-A1 alloy core enriched in Lithium-6 in tubular aluminum target elements. The alloy core is displaced during a forming process and its location must be redetermined before processing can be completed. A low-flux mobile neutron radioscopy system was employed in these studies as a model system for possible on-line, in-plant use. A series of core end sections of target tubes containing from 0.1 to 4.6 grams of Lithium-6 per foot of length were examined radioscopically with thermal neutrons. The system was able to determine the extent of lithium alloy core from the highest concentrations down to about 0.2 grams of Lithium-6 per ft within one minute of data collection time.

0703 Isotopic Power Supplies

Refer also to citation(s) 51624

0704 Economic, Industrial, and Business Aspects

50654 (CONF-900802–8) **A national biomedical tracer facility (NBTF).** Erb, D.E. (USDOE, Washington, DC (USA)); Moody, D.; Peterson, E.; Mausner, L.; Atcher, R. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 200. American Chemical Society national meeting; Washington, DC (USA); 26-31 Aug 1990. Order Number DE90017816. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The production, supply, and sale of isotopes and related services originating in Department of Energy production and research facilities has been a long-standing activity of DOE and predecessor organizations (AEC and ERDA). The authority for this activity is derived from the Atomic Energy Act of 1954, as amended. Stable isotopes and radioisotopes, together with related services, are now being produced in many DOE production and research facilities at several DOE installations which presently include: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), EG&G Mound Laboratories (Mound), Idaho National Engineering Laboratory (INEL), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Westinghouse Hanford Company (WHC), and the Pacific Northwest Laboratories (PNL) at Richland, Washington. The products and services are, in many instances, unique in that their production and processing can be performed only in production and research facilities owned by, and operated for, DOE. In some instances, DOE is the sole supplier of such isotope products and services in the Western World. These products and services are an outgrowth and an extension of DOE (ERDA and AEC) research programs, and have found wide applications in research, industry, agriculture, medical diagnosis and therapy. These technologies, and related products and services, have had a profound effect on the quality of life now enjoyed worldwide. This report reviews operations and purpose of the National Biomedical Tracer Facility.

0705 Health and Safety

Refer also to citation(s) 52238

08 HYDROGEN

50655 (PB–90-780610/XAB) **Fuel to the future: Safety in ground-based liquid hydrogen logistics (video). Audiovisual.** Hasty, S.L. Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab. Jul 1988. vp. Contract N00039-87-C-5301. (CPIA-VT–02). Source: NTISAV$139.00.

The videotape Fuel to the Future - Safety in Ground-Based Liquid Hydrogen Logistics is approximately 30 minutes in length and was produced in conjunction with Air Products and Chemicals, Inc., Allentown, PA. The videotape offers an overview of the production, properties, hazards, handling, storage, and transportation of liquid cryogenic hydrogen fuel.

0801 Production

50656 (CONF-9010173–2) **Development of inorganic membranes for gas separation.** Egan, B.Z.; Fain, D.E. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From 7. DOE-PETC/AIST-NEDO joint technical meeting; New Orleans, LA (USA); 8-12 Oct 1990. Order Number DE91000726. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Hydrogen for commercial coal liquefaction processes may be provided by a coal gasification plant operated to maximize hydrogen production. Hydrogen is a major chemical requirement for coal liquefaction, and the use of liquefaction by-products such as mineral ash residue as feed to the gasifier can improve the overall process efficiency and economics. Also, recovery of hydrogen from gaseous streams in the coal liquefaction plant can have a significant impact on coal liquefaction process economics. In these hydrogen production scenarios, there is a need to improve the quality of the hydrogen produced by separating the other impurity gases from it. The DOE-Fossil Energy AR&TD Materials Program is presently developing inorganic membranes for gas separation, including the recovery of valuable resources such as hydrogen from hot-gas streams. A summary of efforts to produce alumina membranes with mean pore radii <5 Å is presented as well as a status report on declassification of this important technology. 2 refs., 7 figs.

50657 (DOE/MC/26367–2873) **Production of low-cost hydrogen: Quarterly report, January–March 1990.** Manufacturing and Technology Conversion International, Inc., Columbia, MD (USA). May 1990. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-89MC26367. Order Number DE90009693. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall objective of the proposed effort is to verify at the laboratory scale, the ability of the MTCI indirectly heated fluid-bed gasifier to economically produce a hydrogen-rich product gas from liquefaction by-product streams and from char produced in mild gasification processes. The proposed effort is aimed at developing an experimental technology data base by defining the process characteristics that would be required for process integration into an overall liquefaction system. This would result in substantial decreases in the cost of hydrogen for the production of competitively priced coal-derived liquid fuels. Activity during this period focused upon the completion of Project Definition. The Project Implementation Plan and Experimental Test Plan were completed. In addition, a detailed description of the experimental test rig to be used for the char gasification tests was also completed. The modified fire-tube bundle has been configured specifically for use in the char gasification tests and has been checked out with an existing pulse combustor modified for retrofitting with the new fire-tube bundle. Fabrication has been completed on the gasifier shell. Installation of the shell, fire-tube bundle, and retrofitted pulse combustor has been completed. Initial shakedown test firing of the unit has begun and is expected to be completed in April. 3 figs.

50658 Photosynthetic water splitting. Greenbaum, E. (Oak Ridge National Lab., TN (USA). Chemical Technology Div.). pp. 184-195 of Photochemical energy conversion. Norris, J.R.; Meisel, D. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). pp. 364 DOE Contract AC05-84OR21400. (CONF-880767–: 7. international conference on photochemical conversion and storage of solar energy, Evanston, IL (USA), 31 Jul - 5 aug 1988).

This paper presents recent progress in the field of photosynthetic water splitting for both in vitro and in vivo systems. It is demonstrated that platinized chloroplasts are a novel photocatalytic material that is capable of the sustained simultaneous photoevolution of hydrogen and oxygen when irradiated with visible light. The results of experiments are reported.

0808 Properties and Composition

Refer also to citation(s) 51622

0830 Combustion

Refer also to citation(s) 51380

09 BIOMASS FUELS

0907 Resources

Refer also to citation(s) 51696

50659 (FC–12-10) **ENFRO review: Volume 10.** Forestry Canada, Hull, PQ (Canada). Dec 1989. 71p. (MICROLOG–90-03285). Source: PC Petawawa National Forestry Institute, Distribution Centre, P.O. Box 2000, Chalk River, ON, CAN K0J 1J0; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

ENFOR is a contract research and development program initiated in 1978, and managed by Forestry Canada. It's objectives are to develop and test methods and systems for increasing forest biomass productivity; to assess the environmental effects of intensified biomass production and harvesting for energy purposes; and to assess social, economic, technical, and institutional influences of, and constraints to, an increasing utilization of forest biomass for energy production. This publication lists the 223 projects which have been completed or are in progress, by initiating year, from 1978/9 to 1988/9. Topics range from inventory, growth, harvesting, processing, and transportation, to environmental impacts and socio-economic impacts and constraints. Included are abstracts of recently issued ENFOR reports aimed at generating sufficient knowledge and technology to realize a marked increase in the contribution of forest biomass to Canada's energy supply.

50660 (MIC–90-03770/XAB) **Bonavista Peninsula fuel-wood supply study.** Highlands Contracting Ltd., St. John's, NF (Canada). ©1987. 80p. Source: NTIS, PC EE07/MF E01.

On cover: Canada/Newfoundland Conservation and Renewable Energy Demonstration Agreement.

Assessment of designated forest areas to establish whether such areas are technically and economically recoverable for fuel chip production, including sawmill residue; investigation of harvesting/chipping options and their costs; investigation of handling, transportation and storage systems and their costs; and provision of a 1-year operating plan plus a 5-year harvesting plan.

50661 (STEV–1989-6) **Indigenous fuels.** Palmberger, B. Statens Energiverk, Stockholm (Sweden). Dec 1989. 45p. (In Swedish). Order Number DE91707882. Source: NTIS (US Sales Only), PC A03/MF A01.

Appendix 3 to the report 'An environmentally adapted energy system', STEV–1990-2.

An examination of available resources of indigenous fuels, show that they will be cosiderable around the year AD 2010. During the 1980:s the use of this fuels have not been restricted by the accessible supplies, but an increased utilization may lead to such a situation. Figures are given for the following fuels: * Felling residues, * Wood, etc., * Spent liquors, * Chips from energy forests, * Straw, * Lucerne, * Grass, * Peat, and * Municipal wastes. (U.W.).

50662 (STEV–1989-R13) **Production and supply of wood fuels from sawmills and board industry in the future.** Flinkman, M. (Sveriges Lantbruksuniv., Uppsala (SE)). Statens Energiverk, Stockholm (Sweden). Dec 1989. 56p. (In Swedish). Order Number DE91707851. Source: NTIS (US Sales Only), PC A04/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

This report aims at estimating the future structure (around AD 2010) of the sawmill- and board industries, with the intention of calculating energy balances and the need for raw materials. From the sawmills the production of wood fuels in 2010 corresponds to an energy value of 7.4-9.4 Twh calculated from three different scenarios. The demand for energy in the board industry is expected to 2.7 Twh in the year 2010, and of this 2.1 Twh is to be produced from wood wastes within the industry itself. (U.W.).

50663 (STEV–1989-R15) **Energy forests, energy crops and straw.** Hansson, Lars. Statens Energiverk, Stockholm (Sweden). Dec 1989. 24p. (In Swedish). Order Number DE91707855. Source: NTIS (US Sales Only), PC A03/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

Efficient farming technologies have resulted in a pronounced overproduction of agricultural crops in Sweden. Though the area used for farming have decreased with approx 20% since world war two the production efficiency have more than compensated for this loss. Before the year AD 2000 another 500000 hectares will be free for alternative farming, of energy forests as well as of energy crops. This report aims at demonstrating the possibility of production increase and cost competitiveness in using energy forests and energy crops as power production source. (U.W.).

50664 (STEV–1989-R17) **Regional bioenergy-balances.** Liljeblad, H. (Interforest AB, Stockholm (SE)). Statens Energiverk, Stockholm (Sweden). Dec 1989. 115p. (In Swedish). Order Number DE91707859. Source: NTIS (US Sales Only), PC A06/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The aim of this study has been to compile and analyse the potential resources of biofuels in the year 2015, i.e. the time after the nuclear phase out, and to establish regional bioenergy-balances within different sectors, from the available resources and possible use of biofuels. The study comprises the following raw materials and corresponding biofuels: * forest raw materials- felling and clearing residues; * by-products from the forest industry - bark, wood-chips etc.; * energy forest; * agricultural energy crops; *straw. The potential resource in the year 2015 corresponds to 83 TWh. (U.W.).

0908 Production

Refer also to citation(s) 50659, 50660, 50662, 50671

50665 (CREDA–2056) **Integrated pulpwood and biomass harvesting.** Ellingsen, J.; Anderson, A.; Barry, K.; Wall, D. Boise Cascade Canada Ltd., Newcastle, NB (Canada). Dec 1984. 39p. (CE–03105). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A project was undertaken to demonstrate the economics and mechanics of an integrated pulpwood and biomass harvesting system. The project was carried out in two phases: Phase I integrated harvesting of primary forest projects in sub-marginal stands and Phase II in operable stands. In both phases, the pulpwood and sawlogs were delivered to the pulpmill and local sawmills, and the remainder of the materials were chipped and delivered to the already existing hog fuel burners at the mill. In Phase I, the sub-marginal area was first harvested for merchantable pulpwood or sawlogs by the use of the labour intensive manual shortwood or tree-length systems. All remaining trees and brush were directionally felled to facilitate processing by the chip harvester. In Phase II, an operable softwood stand was harvested by forwarding full trees to roadside, removing all merchantable materials. The chipper was then used to process the logging residues and unmarketable residuals. The residuals were felled and chipped at the stump or skidded to roadside, full tree and chipped. To establish chipping productivity under various conditions, the following methods were tried: chipping logging residue at the stump, (Phase I); chipping logging residue at roadside, (Phase I and II); and chipping full trees at roadside, (Phase I and II). Phase I of the project was completed by the end of February 1984. By that time it was demonstrated that integrating pulpwood and biomass harvesting systems is a viable treatment for sub-marginal areas that are otherwise inoperable. Phase II was operational by mid-June with the addition of a container system for

transporting the hog fuel. As of October, 1984, this system had proved to be both economical and dependable. 11 figs., 5 tabs.

0909 Processing

Refer also to citation(s) 50751

50666 (CONF-900512--Absts.) **Twelfth symposium on biotechnology for fuels and chemicals: Program and abstracts.** Scheitlin, F.M. (ed.). Oak Ridge National Lab., TN (USA). [1990]. 141p. Sponsored by U.S. DOE Conservation & Renewable Energy; Gas Research Institute. DOE Contract AC05-84OR21400. From 12. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN (USA); 7-11 May 1990. Order Number DE91000602. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report is the program and abstracts of the twelfth symposium on biotechnology for fuels and chemicals, held on May 7–11, 1990, at Gatlinburg, Tennessee. The symposium, sponsored by the Department of Energy, Oak Ridge National Laboratory, Solar Energy Research Institute, Badger Engineers, Inc., Gas Research Institute, and American Chemical Society, consists of five sessions: Session 1, thermal, chemical, and biological processing; Session 2 and 3, applied biological research; Session 4, bioengineering research; and Session 5, biotechnology, bioengineering, and the solution of environmental problems. It also consists of a poster session of the same five subject categories.

50667 (NRC–29895, pp. 279-301) **Novel synthetic polymer membranes for pervaporation.** Yoshikawa, Masakazu (Kyoto Univ. (Japan)); Shimidzu, Takeo. National Research Council of Canada, Ottawa, ON (Canada). 1989. (CONF-8806495--: Symposium on advances in reverse osmosis and ultrafiltration, Toronto (Canada), 7-10 Jun 1988; CE–03179). In *Advances in reverse osmosis and ultrafiltration.* 598p. Source: Canada Institute for Scientific and Technical Information, Montreal Rd., Ottawa, ON, CAN K1A 0R6. Prices: PRICES UPON REQUEST.

A description of a fixed carrier membrane is presented. To demonstrate the usefulness of fixed carriers in synthetic polymer membranes, studies on novel synthetic polymer membranes for pervaporation of water-ethanol mixtures are described. Among these novel synthetic polymer membranes, some showed ethanol-permselectivity and others water-permselectivity. It was found that separation selectivity was systematized by making use of membrane polarity. It was made clear that membrane polarity is one of the most promising parameters in the development of novel membrane materials for the separation of aqueous ethanol solutions. 50 refs., 11 figs., 2 tabs.

0910 Properties and Composition

50668 (DTH-LET-RE–90-4) **Pyrolysis and gasification of straw: Part report 2: Tar produced during the pyrolysis of straw as a fluid fuel.** Olsen, G.; Gabriel, S.; Henriksen, U.; Koch, T.; Kofoed, E.; Pedersen, P. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Energiteknik. Apr 1990. 51p. (In Danish). Contract EM-1383/88-5. Order Number DE91707358. Source: NTIS (US Sales Only), PC A04/MF A01.

EFP-88.

The aim of the project was to investigate potentials for the utiliation of tar - produced during the pyrolysis of straw - as a liquid fuel. The production of tar as a result of this process, according to relevant literature, amounts to roughly 40% (w/w) of the volume of straw, the exact percentage depending on conditions of process temperature, heating-up rate, size of particles, the process pressure and the length of time the process takes in the reactor. During the course of this project continual pyrolysis of straw has resulted in a tar production of 6%, whereas gasification produces only 1%. The tar produced can be seen as a complex mixture of condensable organic compounds including many aromatic ones. The tar is characterized as having a large content of combinations contraining oxygen of which many, among others acids, alcohols and phenols, are soluble in water. 40 combinations were identified through the analysis of the tar produced by pyrolysis of straw. Phenols, naphthalene, benzene and cresols constituted the highest content, with values varying from 37000 to 16000 ppm. The combustion value of the tar produced by pyrolysis and its fractions was found to be about 35 MJ/kg. The results achieved are evaluated in comparion to those found in relevant literature and a short descriptions of other methods of thermochemical conversion relating to straw are offered. Utilization of this tar as a fluid fuel necessitates refining through a number of stages, both the technical and economic aspects of which are difficult to evaluate. An analysis of the technology expected to be used with regard to refining of biomass tar could point to the possibility of 2.5% of the used straw being converted to gasoline or diesel oil products that will prove more expensive than those produced by conventional methods. (AB).

50669 (MDF/PQ–3209-5) **Methods of measuring cut or shredded ligno cellulosic matter.** Ministre Delegue aux Forets, Quebec, PQ (Canada). Apr 1989. 59p. (MICROLOG–90-02502). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report defines the measuring methods to be used for cut or shredded wood produced by the harvesting of wood at the edge of forest lanes. The following cases are considered: large quantities (heaps, vehicle and ship deliveries), and small quantities such as samples and individual chunks of wood. The topics covered are: measurement of bulk matter (weight and apparent volume), sampling, and laboratory measurements (size distribution, distribution according to species of trees, solid density, moisture, and chemical composition). All calculations are made according to standardized international units. A glossary of technical terms is provided. 2 figs., 1 tab.

0920 Combustion

Refer also to citation(s) 50361, 50501, 51380

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50751

50670 (ADI–2013) **Wood chip boiler modifications: Final report.** Adi Ltd., Fredericton, NB (Canada). 1982. vp. (CE–03098). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The purpose of this report is to evaluate the feasibility of utilizing wood fuel in a fully automatic boiler plant. The wood chip-fired boiler system, presently in service at the Maritime Forest Ranger School, became operational for the 1978-79 heating season. Operating experience during the first season of operation prompted several modifications which resulted in improved performance in the 1979-80 heating season. Subsequent operating experience indicated other potential areas for further improvement of plant reliability. It also became apparent that additional equipment could effectively expand the range of usable cull wood and thereby reduce fuel costs. The major improvement required was the installation of a chip screen and dust collector to expand the range of usable cull wood and, at the same time, eliminate the risk of wood dust explosion. The chip screen and transport system was installed in December 1980, and after minor adjustments, became functional in January 1981. It was found that the addition of the screen virtually eliminated obstructions in the chip feed systems throughout the 1980-81 and the 1981-82 heating seasons. The dust collector was not installed due to inadequate space in the existing plant. In general, all the various modifications and improvements contributed to a successful demonstration project. The screen installation has a payback period of approximately one year. As well as economic savings, the functional reliability of the plant was significantly improved, while at the same time, reducing the dependency on the oil-fired standby system. 15 figs., 5 tabs.

50671 (CS–85-50) **Bonavista Peninsula fuelwood supply study.** Highlands Contracting Ltd., Gander, NF (Canada). Mar 1987. 89p. (MICROLOG–90-03770). Source: PC Newfoundland

Dept. of Mines, Geological Survey Branch, P.O. Box 4750, St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study was designed to produce a cost per tonne for delivered fuelwood chips on the Bonavista Peninsula, Newfoundland. In the first stages, localized forest biomass harvesting blocks were developed from a widely dispersed pattern of stands within Forest Management Unit 2. These blocks, which had been deemed unsuitable for conventional harvesting, were assessed along with mill residue sources. Fuel harvesting, processing, transportation and delivery machinery were reviewed and refined to components and systems whose production was compatible with projected requirements (i.e. 15,000 green tonnes). Biomass harvesting data were correlated with machine and systems data and analyzed. A fuelwood supply in excess of 50 years was established. One- and five-year harvesting plans identified sites for summer operations in the Ocean Pond area and winter operations on the Bloomfield Access Road. The average cost to deliver fuel wood chips and mill residue to end-users on the Bonavista Peninsula is $27.40/green tonne or $49.81/oven-dry tonne. An important result of the study is that 12 permanent jobs would be created as a result of the chip supply operations. 6 refs., 7 figs., 21 tabs.

0940 Transport, Handling, and Storage

Refer also to citation(s) 50660

50672 (TP–9519) **Assessment of the safety of transportation, distribution and storage of methanol fuels: Summary report.** Webb (R.F.) Corp. Ltd., Ottawa, ON (Canada). [1990]. 183p. (MICROLOG–90-04492). Source: PC Air Pollution Control Directorate, Ottawa, , CAN ; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An investigation has been made of the comparative safety of storage, transport, and distribution of high-methanol and conventional transportation fuels in Canada. The substitution of methanol fuels for diesel fuel is expected to degrade the level of fire safety in diesel domains, but to no greater degree than would be experienced if gasoline were substituted for diesel. The outstanding advantage of methanol is that fires involving that fuel burn with a low radiant heat emission, therefore the area in which casualties and property damage occur will be substanially smaller than in gasoline and diesel fires. This advantage will, however, be offset by a somewhat greater frequency of spills and perhaps also of fire incidents because of the higher volume of methanol required in vehicles compared to gasoline and diesel fuel. Methanol distribution is not expected to increase the risk of toxic effect to industry employees when the comparison with gasoline includes the effect of the benzene component of most gasolines. Introduction of methanol fuels will require some modifications to current fuel safety regulations, but an excellent basis already exists for the control and monitoring of spills of methanol in transportation, storage and distribution and for provision of information and human resources to assist local authorities in emergencies. The safety of methanol can be improved by changes in the fuel and in means to detect spills. It is concluded that provided certain recommendations are followed, there is no reason why the development or the metahnol fuel market should be delayed by concerns over the relative safety of metahnol compared to gasoline. 43 refs., 5 figs., 33 tabs.

0950 Environmental Aspects

50673 (NBE–90-04559) **Draft guidelines for an environmental impact assessment: 25 MW wood-fired generating station - Sussex, N.B.** New Brunswick Dept. of the Environment, Fredericton, NB (Canada). 9 May 1990. 26p. (MICROLOG–90-04559). Source: PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This article provides guidelines relating to the substance, scope and conduct of an Environmental Impact Assessment (EIA) of the proposal of the New Brunswick Department of Natural Resources and Energy to construct and operate a 25 MW wood-fired generating station in the Sussex area of New Brunswick. The conduct of the EIA and the preparation of the report are discussed with regard to the following concerns: consultations with specialists and the public, identification of the valued environmental components, choice of objective criteria for the determination of the importance of the impacts, time and space boundaries of the study, study strategy, prediction of the environmental effects, commitment to monitoring, prevention, mitigation and compensation, description of the existing environment and the project, justifications of the project, and evaluation of alternatives. 5 refs.

50674 **National estimates of residential firewood and air pollution emissions.** Lipfert, F.W. (Brookhaven National Lab.,Upton, NY (US)); Dungan, J.L. pp. 479-487 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper presents estimates for the distribution and quantity of use of residential firewood in the United States. The available survey data from other states are in agreement with the relationship derived from New England; no constraints due to wood supply are apparent. This relationship indicates that the highest density of wood usage (Kg/ha) occurs in urban areas; thus exacerbation of urban air quality problems is a matter of some concern. The data presentation gives an upper limit to this density of firewood usage which will allow realistic estimates of air quality impact to be made.

0960 Health and Safety

Refer also to citation(s) 50672, 51881

0980 Waste Management

Refer also to citation(s) 50335, 50661, 50666, 51051

50675 (STEV–1989-R12) **Environmental sceenarios for energy from waste up till AD 2015.** Cairen, S. Statens Energiverk, Stockholm (Sweden). Dec 1989. 28p. (In Swedish). Order Number DE91707849. Source: NTIS (US Sales Only), PC A03/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

Three main scenarios, concerning power production from refuse derived fuels, are described at the year AD 2015. Scenario 1 concerns combustion, Scenario 2 is primarily directed towards recycling and extraction of sludge digestion gas, but combustion is also of some importance. Scenario 3 is a prohibition scenario where combustion of municipal wastes does not occur and where landfilling plays a major role. The most probable of these three cases is scenario no 2. The report treats the three cases by stating the basic conditions of today, a 'control' station 1995-2000, a second 'control' station 2005-2010 and the final goal year 2015.

50676 (STEV–1989-R26) **Costs and availability for felling residues in the long run.** Loenner, G. (Sveriges Lantbruksuniv., Uppsala (SE)); Parikka, M.; Toernqvist, A. Statens Energiverk, Stockholm (Sweden). Dec 1989. 63p. (In Swedish). Order Number DE91707875. Source: NTIS (US Sales Only), PC A04/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The aim of this study has been to estimate a cost level on retrieving residues from felling activities, and to try to relate this costs to potential removable quantities in the form of marginal-cost diagrams. Already known and almost completed techniques would suffice to profitably use nearly 90% of available quantities, with the present marginal price-level on wood fuels. This means 55 TWh, an increase with 23 TWh compared with the situation today. (U.W.).

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 50264, 50275, 50302

50677 (DOE/PC/89866–T2) **Direct conversion of light hydrocarbon gases to liquid fuel: Quarterly technical status report No. 8 for second quarter FY 1990.** Foral, M.J. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. 1990. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89866. Order Number DE91000870. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this program is to investigate the direct conversion of light gaseous hydrocarbons to liquid transportation fuels via a partial oxidation process. The process will be tested in existing pilot plant to obtain credible mass balances. Specific objectives to be met include determination of optimal process conditions, investigation of various processing options (e.g. feed injection, product quench, and recycle systems), and evaluation of an enhanced yield thermal/catalytic system. Economic evaluation of the various option will be performed as experimental data become available. The project is of two year's duration and contains three major tasks: Project Management Plan, Pilot Plant Modification, and Comparison of Preliminary Data With Los Alamos Model: We will determine if the kinetic model developed by Los Alamos National Laboratory can be used to guide our experimental effort. Other subtasks under Task 3 include: Pressure/Temperature/Reaction Time Effects; Study of Different Injection Systems: Different schemes for introducing and mixing reactants before or within the reactor will be evaluated theoretically and/or experimentally; Study of Different Quench Systems; Effect of Reactor Geometry; Effect of Reactor Recycle; and Enhanced-Yield Catalyst Study. 5 refs., 12 figs., 4 tabs.

50678 **Characterization of NH_3 adsorbed on γ-Mo_2N by NMR spectroscopy.** Haddix, G.W. (Lawrence Berkeley Lab., CA (USA)); Jones, D.H.; Reimer, J.A.; Bell, A.T. *Journal of Catalysis (USA)*, 112(2): 556-564 (Aug 1988). DOE Contract AC03-76SF00098.

Nuclear magnetic resonance techniques were used to study the structure and dynamics of NH_3 adsorbed on high-surface-area ($\approx$100 m^2/g) γ-Mo_2N. Proton NMR measurements indicate that NH_3 adsorbs associatively at 298 K, but decomposes on the surface upon heating. The species created by this decomposition are strongly held NH_2, NH, and atomic N and H. Part of the NH_3 adsorbed at 298 K undergoes rapid rotation and translation on the surface, while the species remaining after high-temperature evacuation are locally immobile. Adsorbed NH_2 rotates rapidly about its twofold axis. 14 refs.

1006 Health and Safety

50679 **Alternative gaseous fuels safety assessment.** Krupka, M.C. (Univ. of California, Los Alamos National Lab., Energy Technology Group, NM (US)); Peaslee, A.J. Jr.; Laquer, H.L. pp. 467-478 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper discusses a relative safety assessment of alternative gaseous and reference liquid fuels utilized for light automotive transportation in the public sector. The assessment methodology is described. Integrated generic physicochemical property and accident scenario point of view. A technique involving a method of eliciting expert judgment combined with a comparative scoring methodology was applied in establishing fuel relative safety rankings. Limitations of this type of assessment are discussed.

1009 Environmental Aspects

Refer also to citation(s) 50337

13 HYDRO ENERGY

50680 (CSCE–CE03156) **Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.** Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. 828p. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

Proceedings were held to discuss various aspects of hydrotechnics. Subjects covered include: mathematical and physical models of liquid flow, hydrology (run-off, floods, storm water management, inventory of hydro-electrical sites), hydro-electrical and pumped-storage power plants (design, construction, operation, and safety, including ice jamming), sedimentation and erosion, offshore structures (design, emergency escape), and water quality. Separate abstracts have been prepared for 9 papers.

1301 Resources and Availability

50681 (CSCE–CE03156, pp. 248-268) **Comprehensive hydroelectric inventory procedure software.** Charron, S. (SNC Inc., Montreal, PQ (Canada)); Guillaud, C. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

CHIPS (Comprehensive hydroelectric inventory procedure software)is a computer-aided design software package that is used to assist in the identification of favourable hydroelectric sites in a hydro inventory study. CHIPS uses watershed boundaries combined with run-off maps and hydrological data to evaluate the average flow of a hydroelectric site and to develop its specific flow duration curve. By using built-in formulae, the package computes the quantities and corresponding costs of each component of a project. Alternatives with apparent advantages can be studied taking into account the hydrology, the potential for flow regulation, the topography, the powerhouse data, the access road and the transmission line length. From this, the program computes all the relevant characteristics and costs of the site, including the annual energy production and the benefit/cost ratio. One application is demonstrated by determining the inventory of hydroelectric potential of the Great Northern Peninsula, Newfoundland. 9 figs., 3 tabs.

50682 (CSCE–CE03156, pp. 523-543) **Use of a multi-reservoir simulation model for evaluating developments in the Bay d'Espoir system.** Gibbs, C. (Acres International Ltd., Niagara Falls, ON (Canada)); Piercy, G.; Richter, S. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

A computer simulation model was set up to model the monthly operation of a multi-reservoir system in southcentral Newfoundland. The model was used to estimate the firm and average energy benefits to be expected from three proposed hydroelectric stations. The Bay d'Espoir system is operated by Newfoundland and Labrador Hydro (NLH). Three additional upstream sites in the Bay d'Espoir system have been proposed for future development, but their operation could affect energy production at two existing plants. A multi-reservoir model, Acres Reservoir Simulation Program (ARSP), was used to determine optimal project features and to assess the energy benefits which could be attributed to each of the proposed stations. ARSP represents a water resource system by a flow network, and optimizes the allocation of water in each time step using the out-of-kilter algorithm. The model proved very useful in studying the proposed plants to the feasibility level. The effect that each plant might have on the energy produced by the

existing plants was assessed, and the true benefit of each new station was thus determined. This was particularly important at Island Pond, where a new station could have a large effect on system operation and energy production. In the case of the Round Pond station, the simulation results also indicated a preferred policy for spillway operation. At the Granite Canal project, results suggested an improved spillway arrangement. In all cases, the optimization of project components and operating policies was simplified, due to the flexibilty of the model. 11 figs.

50683 (CSCE–CE03156, pp. 599-615) **Grand Falls - Morrell integrated development potential pump storage scheme.** Ismail, S. (NB Power, Fredericton, NB (Canada)); Harriman, F.B.; Hayward, D.G. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

The potential integrated pump storage scheme studied in this paper involves the development of two sites on the Saint John River in New Brunswick. The upstream site, at Grand Falls, would have a 300 MW low-head pump storage capability. The downstream site, near Morrell, would have a 140 MW conventional hydro electrical development. Results of a preliminary study to determine the technical feasibility of the proposed developments, as well as the operating constraints of such a facility are presented. The impact of the development on the ice regime in the downstream reach of the Saint John River during the critical ice run period is also discussed. The pre-feasibilty study concluded that the development of Grand Falls-Morrell integrated pump storage scheme is technically feasible with virtually no operational constraints. The value of the proposed development will be enhanced by increasing the normal operation water level in the Grand Falls head-pond. The Grand Falls headpond increase is presently being studied. A hydrotechnical analysis concluded that the proposed integrated development would reduce the potential and severity of ice jam flooding along the river reach downstream of the Morrell dam. Also included are data on hydro power generation in New Brunswick. 3 refs., 7 figs., 1 tab.

1302 Site Geology and Meteorology

50684 (CSCE–CE03156, pp. 269-285) **Computation of the probable maximum precipitation for the Ontario Hydro dam safety assessment program.** Lorant, F.I.; Elsayed, E.E.M. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

The Dam Safety Assessment Program, initiated in 1986, entails the design review and integrity assessment of aproximately 288 existing dams in Ontario. The hydraulic component of the program requires the establishment of an inflow design flood for each of the dam sites. For high hazard dams, the inflow design flood is the probable maximum flood (PMF), which is generated by the probable maximum precipitation (PMP). Winter/spring and non-snow-melt season PMPs are estimated for basins across Ontario. Moisture, in selected extreme storm events, is maximized and transposed to the area of interest. The maximization is based on the ratio of the 50-year maximum precipitable water, at the basin to be studied, to the storm's precipitable water. Adjustments are made to allow for the orographic effects. The snow-melt component of the winter/spring PMP is based on snow-pack and critical temperature sequence data. Generally, the PMP estimates are higher for the winter/spring season (including snow component), except for small southern Ontario basins. 5 refs., 5 figs., 3 tabs.

50685 (TAC–CE03154, pp. 151-170) **Geotechnical considerations for proposed tunnels in Queenston Shale, Niagara Falls, Ontario.** Semec, B.P. (Ontario Hydro, Toronto, ON (Canada)); Huang, J.H.S.; Lee, C.F. Tunnelling Association of Canada (Canada). 1989. (CE–03154). In *Canadian tunnelling, 1987/88.* 237p. Source: BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN.

A new hydroelectric generating station has been proposed in Niagara Falls, Ontario, near the existing Sir Adam Beck stations. The project features twin tunnels, each 7.7 km in length and 10.7 m in finished diameter, to be constructed in a uniform Upper Ordovician shale unit. This shale possesses relatively high in situ horizontal stresses and exhibits time-dependent deformation towards openings upon excavation. Rock mechanics studies on this shale unit are described, including in situ stress measurements, a tunnel stress analysis and stability assessment, and laboratory tests. The preliminary test results indicate a significant potential for time-dependent deformation and efforts are underway to define the stress-strain-time relationship and to evaluate the rock-structure-time interaction over the projected service life of the underground openings. 26 refs., 15 figs., 3 tabs.

1303 Plant Design and Operation

50686 (CSCE–CE03156, pp. 428-447) **River intake works for hydroelectric plant in Papua New Guinea.** McCreath, P.S. (Klohn Leonoff Consulting Engineers, Richmond, BC (Canada)); Neil, C.R.; Mannerstrom, M.C.; Swatsky, L.F. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

This paper describes the design, construction and operation of the hydroelectric power plant serving the Ok Tedi mining development in Papua New Guinea. The 50 MW plant draws water from a run-of-river intake on the Ok Menga, a torrential mountain stream in tropical rain forest subject to frequent flash floods and carrying substantial sediment loads; conditions which posed design and construction problems for a diversion weir and intake. Site investigations included the monitoring of precipitation, streamflow and flood levels, the sampling of suspended sediment, and special measurements of bed material and bed load. A hydraulic model was then constructed to examine alternative forms of weir construction and to study the hydraulic behaviour of intake chamber designs, with special attention to exclusion and ejection of coarse sediment. Initial operating experience has generally confirmed the validity of the design, although difficulties arose with organic debris and an excessive inflow of coarse sediment due to inexperienced operation. Difficulties have also been encountered with communications and with the water level monitors. The plant has successfully met its prime objective of replacing expensive diesel power with hydro power, and has provided 75% to 90% of the energy requirements of the site since May 1988. At the intake site, the weir and aprons have all performed successfully for flows up to 6000 m^3/s and water levels up to 2.6 m above weir crest, no significant damage having been observed. 3 refs., 6 figs.

50687 (CSCE–CE03156, pp. 500-522) **Civil engineering challenges on Paradise River Hydro Development - Newfoundland.** Helwig, P.C. (ShawMont Newfoundland Ltd., St. John's, NF (Canada)); Besaw, D.M.; Power, R.F.; Connors, R.C. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

The essential challenge in the design of hydroelectric facilities is to evolve a concept which fits the topographical features of the site, meets environmental and aesthetic criteria and is cost-effective. In this case study, the 8MW, 38m gross head Paradise River Development, on the Burin Peninsula, is dominated by a steep-sided box canyon and offers challenges seldom encountered on small hydro-electric developments. The most original civil engineering features include a thin double curvature arch dam, only the

second of its kind in Canada, and river diversion via an unlined diversion-cum-power tunnel designed for high velocity supercritical flow. Other structures are of more conventional design. This paper focuses on the project's conceptual design (including 4 alternatives); design considerations for hydrology, access road and site infrastructure, river diversion, arch dam and spillway, intake gate, supply tunnels and penstock, and powerhouse; and construction time-frames for access road and structure excavations, major civil works, tunnel works, diversion inlet structure and river diversion, arch dam, intake, powerhouse, and reservoir clearing and filling. The project was realized in 22 months, from a prefeasibility study to project completion. 7 refs., 8 figs., 3 tabs.

50688 (STF–60A89016) **Vacuum-gauged valve at the lake Tovatna, Driva hydroelectric power plant: Checking.** Berg, A. Norsk Hydroteknisk Lab., Trondheim (Norway). Jan 1989. 78p. (In Norwegian). Order Number DE91707658. Source: NTIS (US Sales Only), PC A05/MF A01.

The report concerns a project dealing with the testing of a vacuum-gauged valve connected to the tunnel inlet structure at the Driva hydroelectric plant in the county of Moere og Romsdal (Norway). The valve includes a floater and a guide wall designed for preventing the formation of air supersaturation at the tunnel inlet. The measurements show the reliability of the vacuum valve principle used in this connection. The valve mentioned is operating with satisfactory when the conditions of net air withdrawal and supersaturation are equalizing the zero level as the pressure level in the gate shaft gradually approaches a balancing value. The equilibrium pressure is a function of the flow of water. 30 figs., 16 tabs., 8 refs..

50689 (STF–60A89018) **Pulsating forces in water filled tunnels.** Solvik, Oe. Norsk Hydroteknisk Lab., Trondheim (Norway). Feb 1989. 92p. (In Norwegian). Order Number DE91707616. Source: NTIS (US Sales Only), PC A05/MF A01.

The report gives a summary of the executed prototype- and model experiments done for determining the influencing level of pulsating forces in water-filled tunnels. The forces are initiated by the existing roughness in the tunnel, and can be used as a primary dimensional factor for the design of solid covers on the tunnel floor or for the method of tunnel lining respectively. The report gives a dimensioning basis for the forces, but underlines the need for further research in this field. 54 figs., 18 tabs.

50690 (TAC–CE03155, pp. 153-162) **Improvements in drilling equipment for large tunnels.** Leavitt, H.A. (Atlas Copco Canada Inc., Dorval, PQ (Canada)); Langlois, M.; Cousineau, L.J. Tunnelling Association of Canada (Canada). 1989. (CE–03155). In *Canadian tunnelling, 1989*. 271p. Source: BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN.

Progressive developments have taken place in drilling equipment used in major underground hydroelectric projects in Canada since 1960. These developments are reviewed in an examination of progress at the Outardes 3, Churchill Falls, Mica Dam, and La-Grande River projects. Details are provided of drilling methods, dimensions of underground structures and amount of rock excavated, and equipment used. One of the most significant advances has been the introduction of the mobile hydraulic drill jumbo, the latest generation of which can double the performance of the largest pneumatic drills and use considerably less energy. Additional benefits have resulted from electrification of drilling equipment, such as improved lighting. 3 refs., 11 figs.

1306 Environmental Aspects

Refer also to citation(s) 50684, 51837

50691 (DOE/BP/01830–6) **A fisheries evaluation of the Wapato, Sunnyside, and Toppenish Creek canal fish screening facilities, spring 1988: Annual report.** Neitzel, D.A.; Abernethy, C.S.; Lusty, E.W. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 111p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AC06-76RL01830. Order Number DE91000203. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Bonneville Power Administration, the United States Bureau of Reclamation, and the Washington State Department of Ecology are funding the construction and evaluation of fish passage and protection facilities at irrigation and hydroelectric diversions in the Yakima River Basin, Washington State. The programs provide offsite enhancement to compensate for fish and wildlife losses caused by hydroelectric development throughout the Columbia River Basin and address natural propagation of salmon to help mitigate the impact of irrigation in the Yakima River Basin. The Wapato, Sunnyside, and Toppenish Creek Screens are three of the facilities in the basin. This report evaluates the effectiveness of the screens in intercepting and returning juvenile salmonids unharmed to the river from which they were diverted. We evaluated the effectiveness of new screening facilities at the Toppenish Creek, Wapato, and Sunnyside canals in southcentral Washington State. Screen integrity tests indicated that fish released in front of the screens were prevented from entering the canal behind the screens. We conducted descaling tests at the Toppenish Creek Screens. We measured the time required for fish to move through the screen facilities. Methods used in 1988 were the same as those used at Sunnyside in 1985 and in subsequent years at Richland, Toppenish/Satus, and Wapato. 11 refs., 11 figs., 14 tabs.

50692 (DOE/BP/01830–8) **A fisheries evaluation of the Westside Ditch and Wapato Canal fish screening facilities, Spring 1989: Annual report.** Neitzel, D.A.; Abernethy, C.S.; Lusty, E.W. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 93p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC06-76RL01830. Order Number DE91000198. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Bonneville Power Administration, the United States Bureau of Reclamation, and the Washington State Department of Ecology are funding the construction and evaluation of fish passage and protection facilities at irrigation and hydroelectric diversions in the Yakima River Basin, Washington State. The programs provide offsite enhancement to compensate for fish and wildlife losses caused by hydroelectric development throughout the Columbia River Basin, and they address natural propagation of salmon to help mitigate the impact of irrigation in the Yakima River Basin. The Westside Ditch and Wapato Screens are two of the juvenile screening facilities. This report evaluates the effectiveness of the screens facilities for intercepting and returning juvenile salmonids unharmed to the Yakima River from which they were diverted. We evaluated the effectiveness of new fish screening facilities in the Westside Ditch and Wapato Canal in south-central Washington State. The screen integrity tests indicated that test fish released in front of the screens could enter the canal behind the screens. The study emphasized salmonids. Test fish were steelhead Oncorhynchus mykiss smolts, spring chinook salmon O. tshawytscha smolts, and rainbow trout O. mykiss fry. Evaluations were conducted during typical spring flows in the diversion. 13 refs., 10 figs., 6 tabs.

50693 (DOE/BP/13084–5) **Pen rearing and imprinting of fall chinook salmon: Annual report, 1989.** Beeman, J.W. (Fish and Wildlife Service, Seattle, WA (USA). Seattle National Fishery Research Center); Novotny, J.F. Fish and Wildlife Service, Seattle, WA (USA). Seattle National Fishery Research Center; Fish and Wildlife Service, Portland, OR (USA). Feb 1990. 33p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AI79-83BP13084. Order Number DE91000200. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of this project is to compare net-pen rearing methods to traditional hatchery methods of rearing upriver bright fall chinook salmon (Oncorhynchus tshawytscha). Fish were reared at several densities in net pens at three Columbia River backwater sites during 1984–1987, and in a barrier net at one site during 1984–1986; methods included both fed and unfed treatments. The purpose of this report is to summarize the results obtained from the unfed treatments and the current return of adults from all fed treatments and the barrier net. 9 refs., 6 figs., 4 tabs.

50694 (DOE/BP/13381–5) **Idaho habitat evaluation for offsite mitigation record: Annual report 1988.** Idaho Dept. of Fish and Game, Boise, ID (USA). Mar 1990. 215p. Sponsored by U.S. DOE Office of Administration and Human Resource Management.

DOE Contract BI79-84BP13381. Order Number DE91000756. Source: NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The Idaho Department of Fish and Game (IDFG) has been monitoring and evaluating existing and proposed habitat improvement projects for steelhead and chinook in the Clearwater and Salmon subbasins since 1984. Projects included in the monitoring are funded by, or proposed for funding by, the Bonneville Power Administration (BPA) under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia Rivers. This monitoring project is also funded under the same authority. A mitigation record is being developed to use actual and potential increases in smolt production as the best measures of benefit from a habitat improvement project. This project is divided into two subprojects: general and intensive monitoring. Primary objectives of the general monitoring subproject are to determine natural production increases due to habitat improvement projects in terms of parr production and to determine natural production status and trends in Idaho. The second objective is accomplished by combining parr density from monitoring and evaluation of BPA habitat projects and from other IDFG management and research activities. The primary objective of the intensive monitoring subproject is to determine the relationships between spawning escapement, parr production, and smolt production in two Idaho streams; the upper Salmon River and Crooked River. Results of the intensive monitoring will be used to estimate mitigation benefits in terms of smolt production and to interpret natural production monitoring in Idaho. 30 refs., 19 figs., 34 tabs.

50695 (DOE/BP/22493–5) **Kokanee stock status and contribution of Cabinet Gorge Hatchery, Lake Pend Oreille, Idaho: Annual progress report, FY 1989.** Hoelscher, B.; Bowles, E.C.; Ellis, V.L. Idaho Dept. of Fish and Game, Boise, ID (USA). Fisheries Research Section. Apr 1990. 63p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AI79-85BP22493. Order Number DE91000204. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The kokanee Oncorhynchus nerka rehabilitation program for Lake Pend Oreille continued to show progress during 1989. Estimated kokanee abundance in late August was 7.71 million fish. Decreased population size is the result of lower hatchery and wild fry recruitment and low age 1+ survival. Lower recruitment of wild fry in 1989 resulted from a smaller parental escapement in 1988 and lower wild fry survival. Six fry release strategies were evaluated in 1989. Two groups were released in Clark Fork River to help improve a spawning run to Cabinet Gorge Hatchery. Survival from the mid-summer release, which was barged down Clark Fork River to avoid low flow problems, was not significantly different from the early release. The final assessment of these release strategies will be evaluated when adults return to Cabinet gorge Hatchery in 1992 and 1993. Fry released to support the Sullivan Springs Creek spawning run also survived will in 1989. Two open-water releases were made during early and mid-summer. 30 refs., 26 figs., 2 tabs.

50696 (DOE/BP/35165–3) **Dworshak reservoir investigations-trout, bass and forage species: Annual report, 1989.** Statler, D.P. Nez Perce Dept. of Fisheries Resource Management, Orofino, ID (USA). Orofino Project Office. Jul 1990. 73p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract BI79-87BP35165. Order Number DE91000758. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Nez Perce Tribe and the Idaho Department of Fish and Game (IDFG) entered into separate intergovernmental agreements with the Bonneville Power Administration in a cooperative four-year effort to study impacts of Dworshak Dam operation on resident fisheries. This third annual report focuses on rainbow trout, smallmouth bass, and forage species. 22 refs., 19 figs., 11 tabs.

50697 (DOE/BP/35167–3) **Dworshak Dam impact assessment and fishery investigation: Annual report 1989.** Mauser, G.; Cannamela, D.; Downing, R. Idaho Dept. of Fish and Game, Boise, ID (USA). Fisheries Research Section. Jun 1990. 24p. Sponsored by U.S. DOE Bonneville Power Administration. Order Number DE91000351. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Bonneville Power Administration (BPA) funded two 4-year research projects to develop recommendations for improving the sport fishery on Dworshak Reservoir. Research began during 1987 as a cooperative effort between the Idaho Department of Fish and Game (IDFG) and the Nez Perce Tribe of Idaho. The Nez Perce Tribe examined smallmouth bass and rainbow trout fisheries. The IDFG evaluated kokanee population dynamics and documented changes in reservoir productivity. 12 refs., 12 figs.

50698 (DOE/BP/36136–1) **Kootenai River wildlife habitat enhancement project: Long-term bighorn sheep/mule deer winter and spring habitat improvement project.** Yde, C. (Montana Dept. of Fish, Wildlife and Parks, Libby, MT (USA)); Altman, G.; Young, L. Montana Dept. of Fish, Wildlife and Parks, Libby, MT (USA); Forest Service, Libby, MT (USA). Kootenai National Forest. Jun 1990. 157p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract BI79-84BP18965 ;BI79-87BP36136. Order Number DE91000805. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Libby hydroelectric project, located on the Kootenai River in northwestern Montana, resulted in several impacts to the wildlife communities which occupied the habitats inundated by Lake Koocanusa. Montana Department of Fish, Wildlife and Parks, in cooperation with the other management agencies, developed an impact assessment and a wildlife and wildlife habitat mitigation plan for the Libby hydroelectric facility. In response to the mitigation plan, Bonneville Power Administration funded a cooperative project between the Kootenai National Forest and Montana Department of Fish, Wildlife and Parks to develop a long-term habitat enhancement plan for the bighorn sheep and mule deer winter and spring ranges adjacent to Lake Koocanusa. The project goal is to rehabilitate 3372 acres of bighorn sheep and 16,321 acres of mule deer winter and spring ranges on Kootenai National Forest lands adjacent to Lake Koocanusa and to monitor and evaluate the effects of implementing this habitat enhancement work. 2 refs.

50699 (DOE/BP/37474–2) **Mainstem Clearwater River study: Assessment for salmonid spawning, incubation, and rearing: Annual report, FY 1989.** Conner, W.P. (Nez Perce Tribe Dept. of Fisheries Management (USA)); Arnsberg, B.D.; Connor, E.; Prewitt, C.M. Nez Perce Tribe Dept. of Fisheries Management (USA); EBASCO Environmental (USA). Jun 1990. 145p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AI79-87BP37474. Order Number DE91000156. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This is the second annual progress report for studies conducted by the Nez Perce Tribe to evaluate the potential for increasing fall chinook salmon (Oncorhynchus tshawytscha) populations and establishing summer chinook salmon spawning in the lower 57.5 km of the mainstem Clearwater River (LMCR) of Idaho. The report presents study methods and preliminary results for the 1988–1989 phase of the study. The overall study plan was designed to quantitatively evalulate the available spawning, incubation and rearing habitat for fall and summer chinook salmon. We also studied steelhead trout (O. mykiss) rearing habitat since there is a stable population of these fish in the LMCR's tributaries and their parr are known to rear periodically in the mainstem. Resident fish were studied to assess the potential for habitat overlap with that of anadromous fish. Based on these findings the Nez Perce Tribe could determine chinook salmon habitat conditions for selected stocks under existing flow and temperature regimes and consult with the US Army Corps of Engineering concerning the effects of Dworshak Dam operation on flows and measures to restore or establish stocks identified in this study. 38 refs., 25 figs., 4 tabs.

50700 (DOE/BP/38372–2) **Development of rations for the enhanced survival of salmon: Annual report, 1989.** Ewing, R.D.; Lagasse, J.P. Oregon Dept. of Fish and Wildlife, Portland, OR (USA). Mar 1990. 22p. Sponsored by U.S. DOE Office of Administration and Human Resource Management; U.S. DOE Bonneville Power Administration. DOE Contract BI79-88BP38372. Order Number DE91000197. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The nutritional quality of feed plays an important role in determining the health and "fitness" of smolts. Commercial fish meal, the major source of protein in salmon rations, may be reduced in quality from poor drying techniques during manufacture. Dietary stress in the hatchery may result. This investigation test the

hypothesis that protein quality of fish rations can influence the survival of smolts and the ultimate return of adults. The test involves a comparison between performances of coho (Oncorhynchus kisutch) and chinook salmon (O. tshawytscha) reared on rations containing very high quality protein derived from vacuum dried meals and those of fish reared on commercial rations, with commercial fish meal as a source of protein. Survival and return of several brood years of test and control fish are used to measure the influence of ration on survival. Rearing and release of tagged fish to date include 1982, 1983, 1984 and 1985 broods of coho salmon (Sandy stock); the 1983 and 1984 broods of fall chinook (tule stock) salmon; and the 1985 and 1986 broods of fall chinook (upriver bright stock) salmon. This report includes recovery data from these marked fish collected through September 1989. 2 tabs.

50701 (DOE/BP/98379–1) **Assessment of present anadromous fish production facilities in the Columbia River Basin: Volume 1, US Fish and Wildlife hatcheries: Final report.** Delarm, M.R.; Smith, R.Z. National Marine Fisheries Service, Portland, OR (USA). Jul 1990. 125p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AI79-89BP98379. Order Number DE91000797. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The goal of this report is to document current production practices for hatcheries which rear anadromous fish in the Columbia River Basin and to identify those facilities where production can be increased. A total of 85 hatchery and satellite facilities operated by the Idaho Department of Fish and Game, Oregon Department of Fish and Game, US Fish and Wildlife Service, Washington Department of Wildlife, and Washington Department of Fisheries were evaluated. The years 1985 to 1987 were used in this evaluation. During those years, releases averaged 143,306,596 smolts weighing 7,693,589 pounds. A total of 48 hatchery or satellite facilities were identified as having expansion capability. They were estimated to have the potential for increasing production by an 84,448,000 smolts weighing 4,853,306 pounds. 2 refs., 25 tabs.

50702 (DOE/BP/98379–2) **Assessment of present anadromous fish production facilities in the Columbia River Basin: Volume 2, Idaho Department of Fish and Game hatcheries: Final report.** Delarm, M.R.; Smith, R.Z. National Marine Fisheries Service, Portland, OR (USA). Jul 1990. 97p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AI79-89BP98379. Order Number DE91000796. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The goal of this report is to document current production practices for hatcheries which rear anadromous fish in the Columbia River Basin and to identify those facilities where production can be increased. A total of 85 hatchery and satellite facilities operated by the Idaho Department of Fish and Game, Oregon Department of Fish and Game, US Fish and Wildlife Service, Washington Department of Wildlife, and Washington Department of Fisheries were evaluated. The years 1985 to 1987 were used in this evaluation. During those years, releases averaged 143,306,596 smolts weighing 7,693,589 pounds. A total of 48 hatchery or satellite facilities were identified as having expansion capability. They were estimated to have the potential for increasing production by an 84,448,000 smolts weighting 4,853,306 pounds. 2 refs., 25 figs.

50703 (DOE/BP/98379–3) **Assessment of present anadromous fish production facilities in the Columbia River Basin: Volume 3, Oregon Department of Fish and Wildlife hatcheries: Final report.** Delarm, M.R.; Smith, R.Z. National Marine Fisheries Service, Portland, OR (USA). Jul 1990. 195p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AI79-89BP98379. Order Number DE91000843. Source: NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The goal of this report is to document current production practices for hatcheries which rear anadromous fish in the Columbia River Basin and to identify those facilities where production can be increased. A total of 85 hatchery and satellite facilities operated by the Idaho Department of Fish and Game, Oregon Department of Fish and Game, US Fish and Wildlife Service, Washington Department of Wildlife, and Washington Department of Fisheries were evaluated. The years 1985 to 1987 were used in this evaluation. During those years, releases averaged 143,306,596 smolts weighing 7,693,589 pounds. A total of 48 hatchery or satellite facilities were identified as having expansion capability. They were estimated to have the potential for increasing production by an 84,448,000 smolts weighing 4,853,306 pounds. 2 refs, 25 figs.

50704 (DOE/BP/98379–4) **Assessment of present anadromous fish production facilities in the Columbia River Basin: Volume 4, Washington Department of Fish hatcheries: Final report.** Delarm, M.R.; Smith, R.Z. National Marine Fisheries Service, Portland, OR (USA). Jul 1990. 149p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AI79-89BP98379. Order Number DE91000844. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The goal of this report is to document current production practices for hatcheries which rear anadromous fish in the Columbia River Basin and to identify those facilities where production can be increased. A total of 85 hatchery and satellite facilities operated by the Idaho Department of Fish and Game, Oregon Department of Fish and Game, US Fish and Wildlife Service, Washington Department of Wildlife, and Washington Department of Fisheries were evaluated. The years 1985 to 1987 were used in this evaluation. During those years, releases averaged 143,306,596 smolts weighing 7,693,589 pounds. A total of 48 hatchery or satellite facilities were identified as having expansion capability. They were estimated to have the potential for increasing production by an 84,448,000 smolts weighing 4,853,306 pounds. 2 refs., 25 figs.

50705 (DOE/BP/98379–5) **Assessment of present anadromous fish production facilities in the Columbia River Basin: Volume 5, Washington Department of Wildlife hatcheries: Final report.** Delarm, M.R.; Smith, R.Z. National Marine Fisheries Service, Portland, OR (USA). Jul 1990. 142p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AI79-89BP98379. Order Number DE91000798. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The goal of this report is to document current production practices for hatcheries which rear anadromous fish in the Columbia River Basin and to identify those facilities where production can be increased. A total of 85 hatchery and satellite facilities operated by the Idaho Department of Fish and Game, Oregon Department of Fish and Game, US Fish and Wildlife Service, Washington Department of Wildlife, Washington Department of Wildlife, and Washington Department of Fisheries were evaluated. The years 1985 to 1987 were used in this evaluation. During those years, releases averaged 143,306,596 smolts weighing 7,693,589 pounds. A total of 48 hatchery or satellite facilities were identified as having expansion capability. They were estimated to have the potential for increasing production by an 84,448,000 smolts weighing 4,853,306 pounds. 2 refs., 25 tabs.

1307 Power-Conversion Systems

50706 (TAC–CE03154, pp. 37-65) **Design of unlined and lined pressure tunnels.** Benson, R.P. (Klohn Leonoff Ltd., Richmond, BC (Canada)). Tunnelling Association of Canada (Canada). 1988. (CE–03154). In *Canadian tunnelling, 1987/88.* 237p. Source: BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN.

Pressure tunnels are required to convey water from the power intake to a surface or underground powerhouse. Proper design is essential to convey the water safely throughout the life of the power plant, without such detrimental effects as excessive leakage and destabilization of the surrounding rock or soil. Aspects of tunnel design are described in detail, including positioning and alignment, construction access, protection against hydraulic jacking and uplift, selection of final lining, design and construction of the steel-lined section, and operational aspects. Within these sections are discussed theoretical and practical issues such as basic hydraulic principles, measurement of in situ stress, safety factors, head losses, leakage control, ground support, rock and liner grouting, and initial filling of the tunnel. 16 refs., 11 figs., 7 tabs.

50707 (TAC–CE03155, pp. 1-17) **Tunnelling for the OK Menga hydroelectric project.** Walia, M. (Klohn Leonoff Ltd., Richmond, BC (Canada)); Stevenson, G.W. Tunnelling Association of Canada (Canada). 1989. (CE–03155). In *Canadian tunnelling, 1989.* 271p. Source: BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN.

The Ok Menga hydroelectric project, when completed, will supply power to the Ok Tedi mine in western Papua New Guinea. The generating plant will have a capacity of 52 MW, utilizing a net head of 171 m on a 2.4 km reach of the Ok (River) Menga. The design and construction of the power tunnel and shafts are described. The main underground components include an intake structure, an intake shaft, a 2.3-km power tunnel and penstock, a headrace shaft, a surge shaft, and a surface powerhouse. Design of the tunnels and shafts involved selecting and proportioning the final lining, siting of the structures, and selection of geometry, excavation and support sequence. The geological setting of the site comprises sedimentary rocks blanketed with layers of colluvium, and the regional geologic structure indicates that extensive deformation of the strata has occurred. Some of the formations of concern were weak and erodible, and required temporary support during excavation by means of shotcrete and rock bolts. The final lining was concrete, supplemented by a steel lining. Typical rates of advance during construction were 35 m/week in weak rocks and 20 m/week in sandstones. Watering-up of the tunnel was successfully completed and insignificant leakage was noted. 8 refs., 8 figs., 6 tabs.

1308 Health and Safety

50708 (CSCE–CE03156, pp. 488-499) **Dam safety programs: Newfoundland and Labrador Hydro.** Barnes, R.D. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

The responsibility for administering dams in Canada lies, principally, with the provinces. However, since most provinces do not have specific legislation directed at the safe operation of dams and dykes, dam safety standards and programs are the responsibility of dam owners. Nearly 1% of dams fail, although this ratio appears to be dropping. Safety can be maximized by ensuring design and construction standards are high; that deterioration is detected and prevented; and that failures are prevented from becoming catastrophes. This paper outlines and provides justification for dam safety activity at Newfoundland and Labrador Hydro, and at Churchill Falls (Labrador) Corporation. Dam safety elements described include: routine surveillance by operations field staff, supplementary surveillance by field inspectors, regular dam maintenance, the Dyke Board of consulting experts who oversee dam operations and maintenance, evaluation of flood handling capabilities, and emergency preparedness plans. The dam safety program is justified in terms of failure and disaster avoidance, public awareness, and insurability. 8 refs., 1 fig., 3 tabs.

14 SOLAR ENERGY

1401 Resources and Availability

50709 A simple procedure for correcting shadowband data for all sky conditions. LeBaron, B.A. (Pacific Northwest Laboratory, Richland, WA (USA)); Michalsky, J.J.; Perez, R. *Solar Energy (Journal of Solar Energy Science and Engineering) (USA),* 44(5): 249-256 (1990). DOE Contract AC06-76RL01830.

A model is presented that corrects the horizontal diffuse irradiance measured using a polar-axis design shadowband. Ratios of true diffuse to uncorrected diffuse measurements are categorized and averaged according to parameters describing the associated geometric screening and current sky conditions. The screening parameter is a geometric calculation for the amount of the sky hemisphere eclipsed by the band. The sky condition parameters account for the anisotropic distribution of the diffuse irradiance across the sky hemisphere. An independent set of shadowband diffuse data is corrected using this parameterization technique. Comparison of these corrected values with concurrent true diffuse irradiance values gives a root mean square error of 6.9 W/m^2 and a regression slope of 0.99. The anisotropic contribution to the total shadowband correction is examined for seven different levels of sky clearness and indicates the importance of its consideration in the model's development. Since the correction ratios are developed from parameters that are not site specific, the model should be generally applicable.

50710 Modeling daylight availability and irradiance components from direct and global irradiance. Perez, R. (State Univ. of New York, Albany (USA)); Ineichen, P.; Seals, R.; Michalsky, J.; Stewart, R. *Solar Energy (Journal of Solar Energy Science and Engineering) (USA),* 44(5): 271-289 (1990).

This paper presents the latest versions of several models developed by the authors to predict short time-step solar energy and daylight availability quantities needed by energy system modelers or building designers. The modeled quantities are global, direct and diffuse daylight illuminance, diffuse irradiance and illuminance impinging on tilted surfaces of arbitrary orientation, sky zenith luminance and sky luminance angular distribution. All models are original except for the last one which is extrapolated from current standards. All models share a common operating structure and a common set of input data: hourly (or higher frequency) direct (or diffuse) and global irradiance plus surface dew point temperature. Key experimental observations leading to model development are briefly reviewed. Comprehensive validation results are presented. Model accuracy, assessed in terms of root-mean-square and mean bias errors, is analyzed both as a function of insolation conditions and site climatic environment.

1403 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50940

50711 Repositioning: Photovoltaic (PV) industry's future. Herwig, L.O. (Department of Energy, Washington, DC (USA)). *Solar Today (USA),* 4(1): 12-15 (Jan-Feb 1990).

A growing consensus among utility/photovoltaic (PV) industry planners believes that substantial high-value power-system applications are now economical and desirable. These applications include power for distribution-system switches, communications, lighting, and other housekeeping needs, as well as remote, off-grid power systems for customers not presently connected to a grid and more than a few thousand feet from an existing feeder line. In addition, by the mid-1990s there may be cost-effective PV-system applications on the grid to augment capacity and voltage at the end of long or overloaded distribution lines. These would displace existing conventional capacity additions-such as gas turbines. PV-power systems will even be considered for upgrading grid distribution stations or distribution-line capacities. A basic understanding of PV materials and cells must be advanced to achieve needed performance and cost goals. These goals include improved module efficiencies, 30-year module and system operating lifetimes, and low installed-system costs. Nearly as important is a continuing need for cooperative work among concerned entities (industry, government, and the public) to improve the processing and performance of modules and the design of a wide range of PV systems. These designs must cover a growing number of application areas, but particularly, the U.S. electric-utility grids. Last, but no less urgent, are satisfying the education and experience needs of the PV and utility industries.

1404 Environmental Aspects

Refer also to citation(s) 50743

50712 Air quality effects of solar energy development. Habegger, L. (Argonne National Lab., Argonne, IL (US)); Lipfert, F.; Allwine, K.J. Jr. pp. 489-496 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper evaluates the potential benefits and damages to air quality that are related to utilization of solar and biomass technologies as alternatives to more conventional energy-producing technologies. It evaluates and compares national and regional cumulative emissions for two solar and biomass growth scenarios in the year 2000. The authors discusses emission-level implications of the solar and biomass scenarios for the ten federal regions. They indicate significant regional differences dependent on technology mix and the relation of emission changes within the regions.

1405 Solar Energy Conversion

Refer also to citation(s) 50658, 50728, 50743, 51264, 51773

50713 (CONF-9003209–1) **Multi-step electron transfer in rigid photosynthetic models at low temperature: Requirements for charge separation and spin-polarized radical ion pair formation.** Wasielewski, M.R.; Gaines, G.L. III; O'Neil, M.P.; Svec, W.A.; Niemczyk, M.P.; Tiede, D.M. Argonne National Lab., IL (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 2. Feldafing international workshop; Feldafing (Germany, F.R.); 24-27 Mar 1990. Order Number DE90017859. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Our results show that porphyrin donor-acceptor molecules possess ion pair states that are destabilized by 0.6 eV in solids relative to their energies as determined from electrochemical measurements in polar liquids. The rates of photoinduced charge separation in these molecules show a monotonic increase with increasing negative free energy of reaction in the solid state at 77 K. This information was used to design a two-step electron transfer molecule which gives a 67% yield of radical ion pair following photoexcitation. The lifetime of this radical pair is unusually long, 4 ms, and exhibits a spin-polarized EPR spectrum which suggests that the electronic coupling between the radicals within the ion pair is only about 0.001 cm^{-1}. This spin-polarized EPR spectrum is very similar to those observed previously for $P^+ - Q^-$ radical pairs produced in both green plant and bacterial photosynthetic reaction centers. It is now possible to study charge separation over fixed distances and orientations using magnetic resonance as well as optical studies. These studies will give us a direct measure of the electronic coupling between an electron donor-acceptor pair as a function of structure and environment and may lead to a better understanding of electron transfer in photosynthesis.

50714 (DOE/ER/13242–6) **Magnetic resonance studies of photosynthetic reaction centers and porphyrins: Final report, June 1, 1987–November 15, 1989.** van Willigen, H. Massachusetts Univ., Boston, MA (USA). Nov 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13242. Order Number DE91000597. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During the period covered by this report research has been concerned with the study of photo-induced electron transfer reactions from porphyrins to acceptor molecules with time-resolved Electron Paramagnetic Resonance (EPR) methods. Excited-state electron transfer reactions are of importance from a fundamental point of view and in connection with applications in homogeneous and heterogeneous photosensitization, photopolymerization, and solar energy conversions. For this reason, the study of photo-induced electron transfer reactions is of considerable interest.

50715 (IC–90/126) **High efficiency double sided solar cells.** Seddik, M.M. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 7p. Order Number DE91603024. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Silicon technology state of the art for single crystalline was given to be limited to less than 20% efficiency. A proposed new form of photovoltaic solar cell of high current high efficiency with double sided structures has been given. The new forms could be $n^{++}pn^{++}$ or $p^{++}np^{++}$ double side junctions. The idea of double sided devices could be understood as two solar cells connected back-to-back in parallel electrical connection, in which the current is doubled if the cell is illuminated from both sides by a V-shaped reflector. The cell is mounted to the reflector such that each face is inclined at an angle of 45 deg. C to each side of the reflector. The advantages of the new structure are: (a) High power devices. (b) Easy to fabricate. (c) The cells are used vertically instead of horizontal use of regular solar cell which require large area to install. This is very important in power stations and especially for satellite installation. If the proposal is made real and proved to be experimentally feasible, it would be a new era for photovoltaic solar cells since the proposal has already been extended to even higher currents. The suggested structures could be stated as: $n^{++}pn^{++}Vp^{++}np^{++}$;$n^{++}pn^{++}Vn^{++}pn^{++}ORp^{++}np^{++}Vp^{++}np^{++}$. These types of structures are formed in wedged shape to employ indirect illumination by either parabolic; conic or V-shaped reflectors. The advantages of these new forms are low cost; high power; less in size and space; self concentrating; ... etc. These proposals if it happens to find their ways to be achieved experimentally, I think they will offer a short path to commercial market and would have an incredible impact on solar cell technology and applications. (author). 12 refs, 5 figs.

50716 (PB–90-257668/XAB) **Survey of selected topics relevant to bioprocess engineering. Technical note (Final).** Hubbard, J.B.; Clark, E.J.; Levelt Sengers, J.M.H. National Inst. of Standards and Technology, Gaithersburg, MD (USA). Thermophysics Div. May 1990. 91p. (NIST/TN–1276). Source: NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

The following is a collection of reports on topics considered important and generic in biotechnology and bioprocess engineering: (1) Isoelectric points of proteins; (2) Solubility and mass transfer of oxygen in bioreactors; (3) Solubility and mass transfer of carbon dioxide in bioreactors. The reports arose from a survey of the past and current biotechnology literature with special effort given to a critique of data measurement quality. The format is as follows. The technological importance of a topic is briefly discussed, followed by a critical review of relevant physical properties, data presentation, and measurement techniques. A conclusions and recommendations section summarizes the findings and contains specific recommendations for future research projects. The last section consists of an annotated bibliography and references pertaining to the survey.

50717 (SERI/TP–211-3905) **Electronic processes in thin film PV materials: Final subcontract report, September 1, 1986–May 31, 1989.** Taylor, P.C. (Utah Univ., Salt Lake City, UT (USA). Dept. of Physics); Williams, G.A.; Ohlsen, W.D. Solar Energy Research Inst., Golden, CO (USA); Utah Univ., Salt Lake City, UT (USA). Dept. of Physics. Aug 1990. 35p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Contract XB-5-05009-2. Order Number DE90000359. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes research to study the effects of defects, impurities, and interfaces on the performance of photovoltaic (PV) devices, particularly hydrogenated amorphous silicon (a-Si:H) and related alloys. The studies of a SI:H and related alloys involve understanding the metastabilities using various analysis techniques, characterizing the defects lying deep within the gap (such as Si dangling bonds) and the general density of electronic states throughout the gap, and understanding interfacial effects, especially as they relate to interfaces important to PV devices. Accomplishments include understanding the kinetics of light-induced defects in films, identifying trapped molecular hydrogen and discovering molecular hydrogen diffusion along the microvoids in a-Si:H, investigating the behavior of the defect photoluminescence band in Si-Ge alloys, discovering an E'-type defect at some a-Si:H/SiO_2 interfaces, initially characterizing some paramagnetic defects induced by rapid thermal quenching, developing a new technique to measure low levels of absorption in films and discovering a peak in the below-gap absorption spectrum that may be interface related, using subgap excitation of electron spin resonance and photoluminescence to probe deep defects, and developing a bistable optical switch based on therma! modulation of the index of refraction in films. 70 refs., 14 figs.

50718 (SERI/TP–211-3949) **Amorphous silicon solar cells prepared at high deposition rates: Annual subcontract report, July 1, 1989–June 30, 1990.** Shen, D.S. (Glasstech Solar, Inc., Golden, CO (USA)); Bhat, P.K. Solar Energy Research Inst., Golden, CO (USA); Glasstech Solar, Inc., Golden, CO (USA). Aug

1990. 24p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000371. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document describes the progress in the research of amorphous silicon solar cells prepared at high deposition rates. By using high excitation frequency (110 MHz) and optimization of deposition conditions, the electronic properties of i-layers deposited from Si_2H_6 or SiH_4 at approximately 2 nm/s approached the properties of low deposition rate films. $B(CH_3)_3$ was used as an alternative p-layer doping gas. The results show that $B(CH_3)_3$ is a better doping gas than B_2H_6, due to its better thermal stability and produces a film with better electro-optical properties. The open-circuit voltage, V_{oc}, of the devices has been improved by using a $B(CH_3)_3$ p-layer and a better p/i interface layer. The short circuit current density, J_{sc}, has been improved by using an ITO/Ag back reflector. The key for fabricating high-deposition-rate SiH_4 devices has been found to be the p/i interface. As a result, high-deposition-rate cells deposited from both Si_2H_6 and SiH_4 source gases reached 10% efficiencies. A 1-cm^2 cell deposited at 2 nm/s from Si_2H_6 reached 10.1% initial efficiency as measured by the Solar Energy Research Institute. 16 refs., 11 figs., 3 tabs.

50719 (SERI/TP-211-3950) **Analysis of loss mechanisms in polycrystalline thin film solar cells: Final subcontract report, April 1, 1988-March 31, 1990.** Sites, J.R. (Colorado State Univ., Fort Collins, CO (USA)). Solar Energy Research Inst., Golden, CO (USA); Colorado State Univ., Fort Collins, CO (USA). Aug 1990. 34p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000372. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our goal for thin-film polycrystalline solar cell analysis was to increase the useful information extracted from relatively straightforward electrical measurements. The strategy was to (1) systematize measurements and reporting, (2) organize results in terms of quantitative values for individual sources of current and voltage loss, and (3) evaluate possible analytical techniques to enhance precision and avoid pitfalls, and (4) insist on a viable physical explanation of each loss mechanism. Current-voltage, quantum efficiency, and capacitance measurements on $CuInSe_2$ and CdTe solar cells from a variety of sources have been analyzed. In many cases losses were identified that may be lessened relatively easily. However, the operating voltage loss due to excessive forward recombination current throughout the depletion region remains the primary obstacle to efficiencies competitive with single crystal cells. 1 tab., 4 figs., 26 refs.

50720 (SERI/TR-211-3664) **Novel thin-film $CuInSe_2$ fabrication: Final subcontract report.** Mooney, G.D. (Arkansas Univ., Fayetteville, AR (USA)); Hermann, A.M. Solar Energy Research Inst., Golden, CO (USA); Arkansas Univ., Fayetteville, AR (USA); Colorado Univ., Boulder, CO (USA). Sep 1990. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Contract XL-8-18017-1. Order Number DE90000345. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes work to study the feasibility of fabricating $CuInSe_2$ (CIS), to be used in photovoltaic cells, by rapid annealing processes including laser processing and rapid thermal processing (RTP). Presently, the chalcopyrite phase of CIS is obtained by thermally annealing elemental Cu and In layers in H_2Se gas. This process is hazardous because of the high toxicity of the hydrogen selenide gas, making the process unattractive for large-scale production. The ability to form the desired chalcopyrite structure with favorable optical and electrical properties by rapid annealing processes would be safer and more conducive to large-scale production. Initial studies of the feasibility of laser annealing the elemental layered structures have been performed using CW argon and Nd:Yag lasers on films fabricated by thermal resistance evaporation in a vacuum of 10^{-6} torr. Characterization of the post-annealed films by x-ray diffraction analysis has shown encouraging results. The laser annealed films have all contained the chalcopyrite phase of CIS, although the percentage of the chalcopyrite phase has been small. Undesirable binary compounds have also formed. To produce higher-quality films, future work will concentrate on increasing the percentage of the desirable phase and eliminating all binary compounds. 4 figs.

50721 Photochemical energy conversion. Norris, J.R. (Argonne National Lab., IL (USA). Chemistry Div.); Meisel, D. 364p. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-880767-: 7. international conference on photochemical conversion and storage of solar energy, Evanston, IL (USA), 31 Jul - 5 aug 1988).

This book presents proceedings in which the important achievements and latest advancements of photochemical energy conversion are summarized. Various aspects of photochemical solar energy, including the basic principles of energy and electron transfer, charge separation, energy conversion in homogeneous and heterogeneous systems, photocatalysis, photoelectrochemisty, photochemistry in organized assemblies, biomimetic photochemistry, photosynthesis, and new strategies to the production of fuels and useful chemical through environmentally clean renewable sources are examined.

50722 Exitaxial InP and related 3-5 compounds applied to solar cells. Wanlass, M.W. (Solar Energy Research Institute, Golden, CO (US)); Horner, G.S.; Gessert, T.A.; Coutts, T.J.; Weinberg, I. pp. 445-458 of Proceedings of the first international conference on indium phosphide and related materials for advanced electronic and optical devices: Volume 1144. Singh, R.; Messick, L.J. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 649 (CONF-8903157-: 1. international conference on indium phosphide and related materials for advanced electronic and optical devices, Norman, OK (USA), 20-22 Mar 1989).

This paper discusses the application of InP and related low-bandgap, III-V alloys grown by atmospheric pressure metalorganic vapor phase epitaxy (APMOVPE) to photovoltaics. The work is presented in two parts. The focus of one study is on the majority and minority carrier transport properties of S-doped InP epilayers. This study has resulted in InP shallow- homojunction cells exhibiting substantial improvements in blue response. However, compensating losses in open-circuit voltage and fill-factor prevented overall gains in cell conversion efficiency. The development of solar cells in epilayers of $InAs_yP_{1-y}$, $Ga_{0.47}In_{0.53}As$ and $Ga_xIn_{1-x}As_yP_{1-y}$ as applied to tandem solar cells is also discussed. Low-bandgap cells with good performance have been fabricated and areas for further improvement have been outlined.

50723 Aspects of processing indium tin oxide/InP solar cells. Gessert, T.A. (Solar Energy Research Institute, Golden, CO (US)); Li, X.; Coutts, T.J.; Wanlass, M.W.; Franz, A.B. pp. 476-487 of Proceedings of the first international conference on indium phosphide and related materials for advanced electronic and optical devices: Volume 1144. Singh, R.; Messick, L.J. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 649 (CONF-8903157-: 1. international conference on indium phosphide and related materials for advanced electronic and optical devices, Norman, OK (USA), 20-22 Mar 1989).

This paper discusses the aspects of electrical contact and antireflection coatings needed in order to fabricate high efficiency indium tin oxide/InP solar cells. It has been determined that low resistance electrical contact can be made to p^- InP by using a AuBe alloy and properly sintering. Low resistance, stable and adherent grid contact can be made to indium tin oxide with the use of Cr/Pd/Au metallization. According to the authors, the design and effects of a double layer antireflection coating using indium tin oxide and magnesium fluoride are discussed indicating that this aspect of cell design still contains several opportunities for improvement.

50724 InP solar cells on silicon substrates. Keavney, C.J. (Spire Corp., Bedford, MA (US)); Vernon, S.M.; Haven, V.E.; Al-Jassim, M.M. pp. 488-500 of Proceedings of the first international conference on indium phosphide and related materials for advanced electronic and optical devices: Volume 1144. Singh, R.; Messick, L.J. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 649 (CONF-8903157-: 1. international conference on indium phosphide and related materials for advanced electronic and optical devices, Norman, OK (USA), 20-22 Mar 1989).

This paper describes InP solar cells which have been made by metalorganic chemical vapor deposition on GaAs-coated Si substrates. Various values of emitter thickness and doping levels were

used for these cells. Air mass zero efficiencies of 7.1% were achieved with this material, and 9.4% with GaAs substrates. Various techniques have been developed for improving the material quality of GaAs-on-Si films, resulting in efficiencies as high as 18% AMO for heteroepitaxial GaAs cells; the efficiencies achievable if these can be successfully applied to InP are calculated.

50725 A review of ITO/InP solar cells. Coutts, T.J. (Solar Energy Research Institute, Golden, CO (US)); Li, X.; Gessert, T.A.; Wanlass, M.W. pp. 466-475 of Proceedings of the first international conference on indium phosphide and related materials for advanced electronic and optical devices: Volume 1144. Singh, R.; Messick, L.J. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 649 (CONF-8903157–: 1. international conference on indium phosphide and related materials for advanced electronic and optical devices, Norman, OK (USA), 20-22 Mar 1989).

This paper presents a review of the performance of indium tin oxide (ITO)/InP solar cells fabricated by a variety of methods. The highest efficiency device has been made using DC magnetron sputter deposition of the ITO and an efficiency of 18.9% global has been achieved. Analysis of type conversion effects near the surface of the p-type InP substrates indicates that all devices appear to operate as n/i/p solar cells. Although the detailed performance of the devices fabricated by different methods appears to be different, it is shown that all can be explained within the framework of the n/i/p model. This is used to indicate directions for the further improvement in efficiency of this device.

50726 Reduction of bulk and surface recombination in GaAs for improved solar cell performance. Wong, D. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Electrical and Computer Engineering); Schlesinger, T.E.; Milnes, A.G. *IEEE Electron Device Letters (Institute of Electrical and Electronics Engineers) (USA),* 11(7): 321 (Jul 1990).

A technique for suppressing recombination centers and increasing minority-carrier diffusion lengths in bulk n-type GaAs is described. It is demonstrated that such pretreatment of the material leads to substantially improved long-wavelength photocurrent collection in Zn-diffused solar cells fabricated directly in the bulk substrates. An improvement in the short-wavelength photoresponse in such cells is shown to result from passivation of the front surface of the cells with ammonium sulfide. These results suggest the possibility of realizing high-efficiency GaAs solar cells fabricated without the use of costly epitaxial technology.

50727 Chemical storage of solar energy kinetics of heterogeneous SO_3 and H_2O reaction - reaction analysis and reactor design. Ranade, S.M. (Univ. of Houston, TX (USA)); Lee, Mawchwain; Prengle, H.W. Jr. *Solar Energy (Journal of Solar Energy Science and Engineering) (USA),* 44(6): 321-332 (1990).

The first energy recovery step in the ammonium hydrogen sulfate (AHS) cycle is the formation of $H_2SO_4(l)$ from $H_2O(g)$ and $SO_3(g)$. It has been determined that the optimum way to accomplish this is by the use of a double pipe tubular reactor. In this paper, a mathematical model for the reactor is presented, applied to the three reaction zones, and a method of numerical solution discussed. Three horizontal pilot-scale configurations, 0.234×10^6 to 5.863×10^6 kJ/h energy release, are discussed and sizing presented. Also, the results for a vertical configuration are presented. The need for additional work on two-phase gas-liquid flow in condensing systems and in annuli has been identified. The most important conclusion is that a high temperature can be achieved in the reactor by the use of a front end adiabatic section followed by nonadiabatic sections to recover the heat released.

1406 Photovoltaic Power Systems

Refer also to citation(s) 50711, 50719, 50720, 50755, 50934

50728 (SAND–90-0612) **Performance of amorphous silicon photovoltaic systems, 1985–1989.** Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE91000480. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the performance of commercial amorphous silicon modules used in photovoltaic power systems from 1985 through 1989. Topics discussed include initial degradation, reliability, durability, and effects of temperature and solar irradiance on peak power and energy production. 6 refs., 18 figs.

1407 Solar Thermal Power Systems

Refer also to citation(s) 50992

1408 Ocean Energy Systems

50729 (CONF-9009249–1) **Ocean thermal energy conversion: Perspective and status.** Thomas, A.; Hillis, D.L. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From MTS '90; Washington, DC (USA); 26-28 Sep 1990. Order Number DE90017665. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The use of the thermal gradient between the warm surface waters and the deep cold waters of tropical oceans was first proposed by J. A. d'Arsonval in 1881 and tried unsuccessfully be George Claude in 1930. Interest in Ocean Thermal Energy Conversion (OTEC) and other renewable energy sources revived in the 1970s as a result of oil embargoes. At that time, the emphasis was on large floating plants miles from shore producing 250–400 MW for maintained grids. When the problems of such plants became better understood and the price of oil reversed its upward trend, the emphasis shifted to smaller (10 MW) shore-based plants on tropical islands. Such plants would be especially attractive if they produce fresh water as a by-product. During the past 15 years, major progress has been made in converting OTEC unknowns into knowns. Mini-OTEC proved the closed-cycle concept. Cost-effective heat-exchanger concepts were identified. An effective biofouling control technique was discovered. Aluminum was determined to be promising for OTEC heat exchangers. Heat-transfer augmentation techniques were identified, which promised a reduction on heat-exchanger size and cost. Fresh water was produced by an OTEC open-cycle flash evaporator, using the heat energy in the seawater itself. The current R&D emphasis is on the design and construction of a test facility to demonstrate the technical feasibility of the open-cycle process. The 10 MW shore-based, closed-cycle plant can be built with today's technology; with the incorporation of a flash evaporator, it will produce fresh water as well as electrical power – both valuable commodities on many tropical islands. The open-cycle process has unknowns that require solution before the technical feasibility can be demonstrated. The economic viability of either cycle depends on reducing the capital costs of OTEC plants and on future trends in the costs of conventional energy sources. 7 refs.

1409 Solar Thermal Utilization

Refer also to citation(s) 51072, 51080

50730 (CSC-TPS–238) **Potential use and performance studies of solar crop driers in Mauritius.** African Energy Programme Research Report Series. Yu Wai Man, Y.K.L. (Univ. of Mauritius, Reduit (Mauritius). School of Industrial Technology). Commonwealth Science Council, London (UK). Jul 1987. 62p. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This research was undertaken with the aim of fulfilling the needs of small-scale farmers. The objectives of the project were to develop and conduct tests on prototype dryers, to evaluate the technical and economic feasibility of the dryers, and to establish acceptability by potential end-users. Thus two experimental prototype solar crop dryers, each for a capacity of about half a tonne, were developed and constructed. They were tested for efficiency when used for drying a range of crops including unshelled and shelled maize, groundnuts, red chillies and rice. An analysis of the experiments indicated that the overall efficiency of the driers ranged from 11 to 18% with forced convection, compared with 7 to 14% when natural convection was used. Preliminary studies on a third drier which was being used commercially on a small scale

gave encouraging results and there was an indication that basalt chippings could have a potential for use as a heat absorber. The capital cost of the prototype driers means they would be most suitable to small-scale farmers grouped in co-operatives or societies. Suggested modifications to increase throughput and reduce cost would make them attractive to individual small farmers. (author).

50731 (DOE/SF/16799–T1) **Central solar heating plants with seasonal storage: Final report on IEA Task 7.** CBY Associates, Inc., Washington, DC (USA). 23 Aug 1990. 34p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-87SF16799. Order Number DE90017289. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Nineteen ninety marks the tenth year of international collaborative research and development of central solar heating plants with seasonal stage storage (CSHPSS). During this decade the economic and political forces that gave rise to the decision to pursue this approach to energy security have been severely tested. This environment of rapidly changing perceptions and priorities has not been ideal for the development of long-range alternative energy policies nor for the support of R&D on long-term solutions to key energy issues. CSHPSS development, however, survived this period of change and uncertainty, and although slowed by cutbacks in the programs of most governments, has nearly reached commercial status in some countries. The program of international cooperation, embodied in the International Energy Agency's Solar Heating and Cooling Programme's Task VII on CSHPSS, can take a good measure of the credit for sustaining and advancing CSHPSS development in the past decade. Today the participants in Task VII can confidently assert that CSHPSS that can provide virtually all of the annual energy requirements for heating and hot water supplies are technically and economically feasible today. This is true even in the most northern latitudes where there is essentially no sunshine for the three coldest months of the year, are technically and economically feasible today. Worldwide, more than 30 CSHPSS have been built and evaluated. Plants large enough to serve communities of 500 dwellings have been built and operated reliably, efficiently, and without interruption for more than eight years. 13 refs., 6 figs., 2 tabs.

50732 (DTH-LV-MEDD–207) **IEA project - Smakkebo.** Moerck, O.; Vejsig Pedersen, P.; Andersen, J.; Christensen, J.E. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. May 1989. 79p. (In Danish). Contract TR-84.549. Order Number DE91707405. Source: NTIS (US Sales Only), PC A05/MF A01.

The aim of the project, carried out under the auspices of the International Energy Agency, was to further interest in member countries for passive and hybrid solar energy systems in residential buildings in relation to energy conservation. The project involved the evaluation of calculation methods the construction of the buildings themselves and data aquisition. In Denmark 55 homes and a communal building were erected and a measuring programme was carried out. Weekly measurements of energy consumption in each house and hourly measurements of temperature and indoor climate were taken. A description of the buildings construction in addition to evaluated data, are presented. (AB).

50733 (DTH-LV-MEDD–212) **Energy retrofitting of older residential buildings with emphasis on utilization of opaque insulation materials.** Bruun Joergensen, O.; Schmidt, C. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering; Danbolind Raadgivning A/S, Copenhagen (Denmark). Mar 1990. 144p. (In Danish). Contract EM-151/88-65. Order Number DE91707371. Source: NTIS (US Sales Only), PC A07/MF A01.

EFP-88.

The project describes how an energy retrofitting of a specific areas containing typical 3 storey buildings from 1945, could be carried out on the massive or poorly insulated walls (bricks or concrete). The exteriors of these walls were covered with glass and a transparent insulation material. A description is given of how solar walls and exterior opaque insulation can be combined. The energy and comfort characteristics of the improvements have been analysed by extensive computer simulations. Risks of degradation of the existing exterior wall due to temperature movements caused by using solar walls have been estimated. It is also shown that the static demands to the sketched solar wall systems have been met. Finally, an economic evaluation of an energy retrofitting has been carried out, in which the economy of using solar walls has been compared to that of using a conventional exterior opaque insulation. Calculations of the expected energy savings show that a reduction of the energy consumption for space heating, of more than 40% is possible. Analyses concerning the thermal comfort show that application of solar walls, because of higher indoor surface temperatures during the heating season, will contribute to improvement of the indoor climate compared to an opaque insulation. During the summer period the increase of the indoor air temperature insignificant. The economic evaluation shows that an energy retrofitting using solar walls in their present simple design using Governmental subsidies, is far more profitable than a conventional exterior opaque insulation of a thickness of 100 mm where no Governmental subsidies. (AB) 22 refs.

50734 (SERI/PR–255-3443) **Polymers as advanced materials for desiccant applications, 1988.** Czanderna, A.W.; Neidlinger, H.H. Solar Energy Research Inst., Golden, CO (USA). Sep 1990. 59p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000385. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report documents work to identify a next-generation, low-cost material with which solar energy or heat from another low-cost energy source can be used for regenerating the water vapor sorption activity of the desiccant. The objective of the work is to determine how the desired sorption performance of advanced desiccant materials can be predicted by understanding the role of the material modifications and material surfaces. The work concentrates on solid materials to be used for desiccant cooling systems and which process water vapor in an atmosphere to produce cooling. The work involved preparing modifications of polystyrene sulfonic acid sodium salt, synthesizing a hydrogel, and evaluating the sorption performances of these and similar commercially available polymeric materials; all materials were studied for their potential application in solid commercial desiccant cooling systems. Background information is also provided on desiccant cooling systems and the role of a desiccant material within such a system, and it includes the use of polymers as desiccant materials. 31 refs., 16 figs., 5 tabs.

50735 (STF–15A89014) **Water based solar heating systems.** Nordgaard, A. Stiftelsen for Industriell og Teknisk Forskning (SINTEF), Trondheim (Norway). Apr 1989. 48p. (In Norwegian). Order Number DE91707625. Source: NTIS (US Sales Only), PC A03/MF A01.

The present report concerns a project dealing with the development of water-based solar heating systems in Norway. Topics covered include: Solar energy characteristics; flat plate collectors; energy- and power efficient houses; solar energy for hot water heating in large-scaled shower installations; simulation programs for solar heating plants. The usefulness of the computer programs TRNSYS and FCHART is analysed. 20 figs., 4 tabs., 22 refs.

1410 Solar Collectors and Concentrators

50736 (DLR-FB–90-11) **Design of highly concentrating solar collectors and solar collector systems.** Koehne, R. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik). Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany, F.R.). 1990. 61p. (In German). Order Number DE91706334. Source: NTIS (US Sales Only), PC A04/MF A01.

The influence of the configuration of symmetric and unsymmetric concentration solar collector systems and of their optical quality on the maximum obtainable thermal efficiency was investigated in a parameter study using the codes CIRCE and CAV2. An optimization was made with respect to the aperature diameter and shape of the cavity receiver. To achieve efficiencies of 70% at absorber temperatures between 800 and 1000deg C, a single dish or systems consisting of many dishes or segments can be used. For higher temperatures only the single dish is suitable. Too extreme flux densities can be avoided by an appropriate cavity shape with spherical or parabolic inner walls. Optimized receiver aperature diameters

can increase the efficiency by 5-10%. (orig.) With 28 figs., 20 refs., 1 tab.

50737 (DLR-FB–90-12) **Some studies related to a new hexagonal compound parabolic concentrator (HCPC) as a secondary in tandem with a solar tower.** Suresh, D. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik). Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany, F.R.). 1990. 39p. Order Number DE91706336. Source: NTIS (US Sales Only), PC A03/MF A01.

Secondary concentrators operate in the focal plane of a point focussing system such as a paraboloidal dish or a tower and, when properly designed, are capable of enhancing the overall concentration ratio of the optical system at least by factors of two to five. It has been demonstrated both analytically as well as experimentally in recent years the viability of using different shapes including Compound Parabolic Concentrators (CPCs) of circular cross-section and 'trumpets' as secondaries. Our current research effort is centered around a HCPC (Hexagonal CPC). Major areas addressed in the present study would include an overview on the state of development of secondary concentrators, some background informations related to the design of a HCPC, the results of an analytical study on the thermal behaviour of this HCPC under concentrated flux conditions, and of a computer modelling for assessing the possible thermal interactions between the secondary and a high temperature receiver. (orig.) With 13 figs., 41 refs.

50738 (DTH-LV-MEDD–211) **Roof space solar collector: Measurements on an experimental house.** Oestergaard Jensen, S. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. Feb 1990. 114p. (In Danish). Contract TR-84.080;Contract EM-1353/86-1. Order Number DE91707369. Source: NTIS (US Sales Only), PC A06/MF A01.

EFP-86.

As in Denmark global solar radiation amounts to only about 400 Wh/m^2 per day in December but to nearly 6000 Wh/m^2 in June, and seasonal heat storage is expensive, it was thought advantageous to develope a cheap and simple solar collector using roof space in order to utilize global radiation for space heating to the maximum. The results of a previous project showed that a roof space collector on the south side of a building could provide 40-50% of the net energy consumption for a reasonably well insulated house. The aim of this project was to produce measurements as documentation for the advantages of using this form of solar collector. Computerized simulation was used to illustrate the energy stream and temperatures in the collector and heat storage facilities. Previous results were confirmed. It is suggested that the system is economical in use, but not so in the case of houses with water born heating systems, as the solar heating system in case is based on air transport of heat. Air to water heat exchangers could probably be used to advantage. (AB) 41 refs.

50739 (DTH-LV-R–90-3) **Larger solar collectors with low flow drift that are integrated in roofs.** Vejsig Pedersen, P. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. Apr 1990. 46p. (In Danish). Contract TR-85.755. Order Number DE91707408. Source: NTIS (US Sales Only), PC A03/MF A01.

The aim was to determine the most suitable operational strategies for larger solar collectors that are integrated in roofs, and to investigate potentials for combining various types of solar collectors and at the same time utilize low flow drift. The use of low flow drift constitutes a need for new design in relation to solar collectors, and this should result in improved economy and a reduction in energy consumption. An experiment was carried out with a solar collector system which used a combination of self circulation and a pump driven drift and which had a container for expansion. The solar heat is pumped to a heat storage system or to where it is ready for consumption. This method makes it possible to guard against boiling (the fluid can be emptied from the collector) and for heat storage to be located in the roof. An experiment is also described where the low flow drift was pump driven. This results in a temperature which is suitable for immediate use and an even temperature in the heat storage facility. Low flow drift in relation to larger solar collectors can be used where high and low temperature collectors are found in a series. An experiment was also undertaken where pumps were coupled together between two types of solar collectors with low flow drift. (AB).

50740 (IC–90/91) **Performance studies of tubular flat plate collectors.** Husain, M.S. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 10p. Order Number DE91604465. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Computations have been performed for flat plate efficiency factor, heat removal factor, heat gained by fluid for different materials used for the tubes and fins of flat plate tubular solar collectors. 3 refs, 17 figs, 4 tabs.

50741 (IC–90/92) **Bondings for tubular solar collectors.** Husain, M.S. International Centre for Theoretical Physics, Trieste (Italy). May 1988. 7p. Order Number DE91604477. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We studied the following four models of constructing solar collectors: tubes bonded above the absorber plate, tubes bonded under the absorber plate tubes in-line with the absorber plate and bondless tubes in-line with the absorber plate. 2 refs, 6 figs.

50742 Thermal and optical performance test results for compound parabolic concentrators (CPCs). Suresh, D. (Univ. of Chicago, IL (USA)); O'Gallagher, J.; Winston, R. *Solar Energy (Journal of Solar Energy Science and Engineering) (USA)*, 44(5): 257-270 (1990).

The primary objective of the present study was to evaluate the performance characteristics (thermal and optical) of a properly truncated CPC that could be used in two-stage solar thermal power generation systems. The CPCs selected for testing were the 5:1 cones with a 25° acceptance angle and an untruncated concentration ratio of 5.6X. Experiments were carried out at the Advanced Components Test Facility of the Georgia Tech Research Institute. Several cones of the same dimensions but with different shell materials, reflector surfaces, and employing various heat removal methods were tested. It has been demonstrated experimentally for the first time that the CPCs with high reflectivity surfaces can have optical efficiencies in the range of 90% and above. In order to verify those results, a computer ray-trace analysis was also performed. These tests have shown that passive cooling alone is adequate for small-scale, low-power systems.

1420 Heat Storage

Refer also to citation(s) 50731

1430 Health and Safety

Refer also to citation(s) 51881

50743 (BNL–44946) **Health, safety and environmental issues relating to cadmium usage in photovoltaic energy systems.** Moskowitz, P.D. (Brookhaven National Lab., Upton, NY (USA)); Fthenakis, V.M.; Zweibel, K. Brookhaven National Lab., Upton, NY (USA). Dec 1989. 29p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. Order Number DE91000123. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the current technology base and hazards associated with two promising thin-film photovoltaic cells that contain cadmium compounds – cadmium telluride (CdTe) and copper indium diselenide ($CuInSe_2$). More specifically, this paper summarizes the toxicological information on cadmium (Cd) compounds; evaluates potential health, safety and environmental hazards associated with cadmium usage in the photovoltaics industry; describes regulatory requirements associated with the use, handling and disposal of cadmium compounds; and lists management options to permit the safe and continued use of these materials. Handling of cadmium in photovoltaic production can present hazards to health, safety and the environment. Prior recognition of these hazards can allow device manufacturers and regulators to implement appropriate and readily available hazard management strategies. Hazards associated with product use (i.e., array fires) and disposal remain controversial and partially unresolved. The most likely effects that

could be expected would be those associated with chronic low-level exposures to cadmium wastes. Because of the general immobility of the cadmium present in these devices and availability of environmental and biomonitoring protocols, chronic hazards can be monitored, and remediated if necessary. Nevertheless, concern about cadmium hazards should continue to be emphasized to ensure that health, safety and environmental issues are properly managed. At the same time, the potential role that these systems can play in ameliorating some important health and environmental hazards related to other energy systems should not be ignored. 27 refs., 5 figs., 2 tabs.

15 GEOTHERMAL ENERGY

50744 (CONF-891185–1, pp. 8, Paper 6) **Hong Kong's future coal requirements.** Au, H.H.W. (China Light and Power Co., Ltd., Kowloon (Hong Kong)). East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference*. 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper briefly discusses the primary sources of electrical power which supplies Hong Kong with its electricity. Since Hong Kong has no energy resources of its own, all of these energy sources must be imported. While most of the earlier power developments came from oil-fired power plants, coal-fired facilities hold the greatest potential for the future. The paper goes on to give statistics on energy consumption between 1978 and 1988 and provides the background on the capacity of the various fossil-fuel facilities currently in use.

1501 Resources and Availability

50745 (DOE/ID/12850–3) **Geothermal development opportunities in developing countries: Seminar proceedings.** Kenkeremath, D.C. Technology Prospects, Inc., Falls Church, VA (USA). 16 Nov 1989. 90p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG07-89ID12850. (CONF-8911226–: Geothermal development opportunities in developing countries, Washington, DC (USA), 16 Nov 1989). Order Number DE90017613. Source: NTIS, PC A05/MF A01 - OSTI.

This report is the proceedings of the Seminar on geothermal development opportunities in developing countries, sponsored by the Geothermal Division of the US Department of Energy and presented by the National Geothermal Association. The overall objectives of the seminar are: (1) Provide sufficient information to the attendees to encourage their interest in undertaking more geothermal projects within selected developing countries, and (2) Demonstrate the technological leadership of US technology and the depth of US industry experience and capabilities to best perform on these projects.

50746 (NMRDI–2-78-5202/II) **Southern New Mexico low temperature geothermal resource economic analysis: Final technical report.** Fischer, C.L.; Whittier, J.; Witcher, J.C.; Schoenmackers, R. New Mexico State Univ., Las Cruces, NM (USA). Southwest Technology Development Inst. Aug 1990. 99p. Sponsored by New Mexico Research and Development Institute. Source: OSTI; NMRDI, Communications Office, Suite M, 457 Washington SE, Albuquerque, NM 87108.

This report presents an overview of geothermal resource development for three-low temperature (i.e, <200°F) sites in southern New Mexico: the Lower Animas Valley, the Las Cruces East Mesa, and Truth or Consequences. This report is intended to provide potential geothermal developers with detailed information on each site for planning and decision making purposes. Included in the overview for each site is both a full site characterization and an economic analysis of development costs associated with the construction and operation of both geothermal and fresh water systems at each of the three locations. The economic analysis focuses on providing utility services to a commercial greenhouse because greenhouse operations are among the most likely candidates for use of the resource base. 9 tabs., 8 figs.

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 50748

50747 (LA–11906-MS) **An evaluation of the geothermal potential of the Tecuamburro Volcano area of Guatemala.** Heiken, G.; Duffield, W. (eds.). Los Alamos National Lab., NM (USA). Sep 1990. 226p. Sponsored by U.S. Agency for International Development. DOE Contract W-7405-ENG-36. Order Number DE91000685. Source: NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Radiometric ages indicate that the Tecuamburro Volcano and three adjacent lava domes grew during the last 38,300 years, and that a 360-m-wide phreatic crater, Laguna Ixpaco, was formed near the base of these domes about 2900 years ago. Laguna Ixpaco is located within the Chupadero crater, from which pyroxene pumice deposits were erupted 38,300 years ago. Thus, the likelihood is great for a partly molten or solid-but-still-hot near-surface intrusion beneath the area. Fumaroles and hot springs issue locally from the Tecuamburro volcanic complex and near Laguna Ixpaco. Analyses of gas and fluid samples from these and other nearby thermal manifestations yield chemical-geothermometer temperatures of about 150° to 300°C, with the highest temperatures at Ixpaco. The existence of a commercial-grade geothermal reservoir beneath the Ixpaco area seems likely. 84 refs., 70 figs., 12 tabs.

1503 Geothermal Exploration and Exploration Technology

Refer also to citation(s) 50745, 50747, 51886

50748 (DOE/ID/12613–1) **Cascade geothermal drilling/corehole N-3: Final report.** Swanberg, C.A. Geothermal Resources International, Inc., San Mateo, CA (USA). 19 Jul 1988. 136p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-85ID12613. Order Number DE90014391. Source: NTIS, PC A07/MF A01 - OSTI.

Two core holes have been completed on the flanks of Newberry Volcano, Oregon. Core holes GEO N-1 has a heat flow of 180 mWm-2 reflecting subsurface temperature sufficient for commercial exploitation of geothermally generated electricity. GEO N-3, which has a heat flow of 86 mWm-2, is less encouraging. Considerable emphasis has been placed on the "rain curtain" effect with the hope that a detailed discussion of this phenomenon at two distinct localities will lead to a better understanding of the physical processes in operation. Core hole GEO N-1 was cored to a depth of 1387 m at a site located 9.3 km south of the center of the volcano. Core hole GEO N-3 was cored to a depth of 1220 m at a site located 12.6 km north of the center of the volcano. Both core holes penetrated interbedded pyroclastic lava flows and lithic tuffs ranging in composition from basalt to rhyolite with basaltic andesite being the most common rock type. Potassium-argon age dates range up to 2 Ma. Difficult drilling conditions were encountered in both core holes at depths near the regional water table. Additionally, both core holes penetrate three distinct thermal regimes (isothermal (the rain curtain), transition, and conductive) each having its own unique features based on geophysical logs, fluid geochemistry, age dates, and rock alteration. Smectite alteration, which seems to control the results of surface geoelectrical studies, begins in the isothermal regime close to and perhaps associated with the regional water table.

1505 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50745, 50746

1506 Environmental Aspects

Refer also to citation(s) 51703

50749 (DOE/NV/10425–T2) **Environmental monitoring at designed geopressured-geothermal well sites, Louisiana and Texas: Quarterly status report, July, August, September 1990.** Groat, C.; Stevenson, D. Louisiana State Univ., Baton Rouge, LA (USA). School of Geoscience. [1990]. 5p. Sponsored by U.S. DOE

Conservation & Renewable Energy. DOE Contract FC07-85NV10425. Order Number DE91000567. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The research objectives of this report are to: implement and maintain the ongoing environmental monitoring program around DOE geopressured-geothermal test well in Louisiana and Texas; analyze and interpret collected data for evidence of subsidence and induced microearthquakes which may be brought about by geopressured-geothermal well testing and development; continue geological-geophysical studies of the Hulin and Gladys McCall sites incorporating new seismic data; continue review of previously identified and tested geopressured-geothermal prospects in Louisiana to determine if any link exists between such reservoirs and the existence of free gas in commercial or subcommercial quantities; and initiate review of geology, co-location and properties of geopressured brines with medium and heavy oil reservoirs in Louisiana utilizing existing maps, databases, reports, and journal articles.

1508 Geothermal Power Plants

Refer also to citation(s) 50745

50750 (EPRI-GS–6890) **Moldular wellhead binary power system: Preliminary design results: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); Pacific Gas and Electric Co., San Francisco, CA (USA). Dept. of Mechanical and Nuclear Engineering. ©Sep 1990. 390p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The modular wellhead binary power system is a binary cycle power plant consisting of equipment packaged in modules for application at geothermal wellhead sites. The power system is intended for installation at various geothermal power plant sites with different types of geothermal resource fluid that range from low temperature (300°F to 375°F) brine to a mixture of high temperature (400°F to 450°F) steam and brine. Seven modular configurations, four water-cooled and three air-cooled, were selected for the purpose of developing their detailed engineering and design. Development of the detailed design of the seven configurations falls under Phase 1 of EPRI's plan to implement the modular wellhead binary power system. Preliminary engineering analyses and design were performed on the mechanical and electrical systems. A computer program was developed to predict the performance of the seven modular configurations and to determine the preliminary sizes of the various equipment for the different types and conditions of the geothermal resource, operating under various ambient conditions. Performance curves and tables were generated from the results of the mechanical systems analyses to determine the range of power output of the various modular configurations under selected combinations of conditions. The net power outputs determined from the normal design condition analyses range from a low of 2688 KW (specific output of 4.69 W-hr/lb) for an air-cooled system which utilizes a low temperature steam/brine mixture, to a high of 5334 KW (specific output of 10.42 W-hr/lb) for a water-cooled system which utilizes a high temperature steam/brine mixture. The analyses also indicated that the power outputs will vary according to the variations in the geothermal resource and ambient conditions. 21 refs., 2 figs., 1 tab.

1510 Direct Energy Utilization

Refer also to citation(s) 50745

17 WIND ENERGY

1704 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50940

1706 Wind Energy Engineering

50751 (EUR–12453) **Deersum energy project: Demonstration Project: Final report.** van Nes, W.J.; van Gemert, P.H.; van Diemen, F.M.P. Centrum voor Energiebesparing en Schone Technologie, Delft (Netherlands). ©1989. 61p. Sponsored by Commission of the European Communities. Contract BM/606/84;Contract WE/607/84. Source: NTIS (US Sales Only), PC A; OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 6.25.

Wind and biogas can be attractive energy sources especially for rural communities. Both sources are tapped in the Deersum Energy Project. Situated in a windy area in the northern part of the Netherlands, Deersum is a small village comprising some fifty homes and ten dairy farms. The objective of the Deersum Energy Project is to demonstrate the feasibility of a wind turbine in combination with a collective manure digestion plant for electricity generation in rural communities. The turbine used in the project is a 160-kW model; the digestion plant has a digester volume of 210 m3 and receives manure from a number of cattle farms. Performance measurements were made in the period from early 1988 until early 1989. The electricity demand of Deersum amounted to 331,000 kWh per year. The wind turbine produced 222,000 kWh electricity per year, which is approx. 10% more than anticipated. Electricity production from the digestion plant amounted to 33,000 kWh per year. This is over 50% less than the design figure, due to a number of teething troubles relating to the manure pumps, desulpherisation of the gas and low efficiency of the conversion into electricity. During the measuring period, the aggregate electricity output amounted to 255,000 kWh per year. Of this 69% (176,000 kWh) was used in Deersum. Thus, the wind turbine and the digestion plant could meet half of the electricity demand of Deersum. The surplus electricity, 31% or 79,000 kWh per year, was delivered to PEB Friesland. During the first year the Deersum Energy Project was not profitable. The average cost price of the electricity was Dfl. 0.33 per kWh. 8 tabs., 41 figs.

50752 (ICA–3) **Static and dynamic investigations of the tower for the OPTIWA experimental wind turbine.** Argyris, J.; Frank, T.; Kirchgaessner, B. Stuttgart Univ. (Germany, F.R.). Inst. fuer Computeranwendungen; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 1984. 140p. (In German). Contract BMFT 03E 8054 A7. Source: Copy held by UB/TIB Hannover.

The tower of the OPTIWA wind turbine is investigated using the Finite Element Method (FEM). Corresponding to the different modes of operation three different FE-idealisations are established. Static calculations are used in order to determine the stresses in different cross-sections of the structure. In a subsequent dynamic investigation the calculation of the eigenmodes and the determination of the time-history-response of the structure to selected rotor loads are performed. All calculations are executed with the Finite Element program system ASKA. (orig.).

50753 (ICA–7) **Design and investigation of the OPTIWA rotor blade using the finite element method.** Argyris, J.; Braun, K.A.; Frank, T.; Kirchgaessner, B. Stuttgart Univ. (Germany, F.R.). Inst. fuer Computeranwendungen; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 1985. 94p. (In German). Contract BMFT 03E 8054 A7. Source: Copy held by UB/TIB Hannover.

This report deals with the investigations of the rotorblades of the experimental wind turbine 'OPTIWA'. Both the projected as well as the constructed blade are described. A short discussion of the calculations for the structural layout is followed by a detailed static and dynamic investigation using the Finite Element Method for the rotorblade idealized by beam elements. The FE-data needed are determined using a method for the shell-beam conversion documented in the report. In order to verify this method calculations are performed applying a more sophisticated model using shell elements. The computational results are compared with measurements gained from experiments described elsewhere. (orig.).

50754 (RISO-M–2761) **Wind turbine test Tellus T-1995, 95 kW.** Aagaard Madsen, H.; Markkilde Petersen, S. Risoe National Lab., Roskilde (Denmark). Test Station for Wind Turbines. Jan 1990. 68p. Order Number DE91707334. Source: NTIS (US Sales Only), PC A04/MF A01.

The report describes standard measurements performed on a Tellus T-1995, 95 kW wind turbine. The measurements carried out

and reported here comprises the power output, system efficiency, energy production, transmission efficiency, rotor power, rotor efficiency, air-brakes efficiency, structural dynamics, loads at cut-in and at braking, rotor torque at stopped condition, flapwise blade bending moments and yaw errors statistics. (author) 4 tabs., 44 ills., 8 refs.

50755 **Hybrid power system operational test results: Wind/PV/diesel system documentation.** Colman, C. (Northern Power Systems, Inc., Moretown, VT (US)). pp. 15.2 of Proceedings of the eleventh international telecommunications energy conference. 1989. IEEE Service Center, Piscataway, NJ (USA) (1989). vp. of (CONF-8910376–: INTELEC '89: 11. international telecommunications energy conference, Florence (Italy), 15-18 Oct 1989).

As a result of the advances in reliability and the increasing acceptance of renewable energy conversion technology, hybrid power systems now represent the preferred choice for electrical power at many remote sites. This paper presents operational data and performance parameters from laboratory tests and similar remote sites currently employing hybrid power system technology. The report focuses on the operational characteristics of the systems as well as describing the power system architecture, control logic, and component performance. The systems include the following power system elements: wind turbines, photovoltaic panels, diesel engine/generators, batteries, and system controls. The project includes an extensive laboratory test program, the development of a computer simulation program, and the collection of short term and long term field data from existing hybrid sites. The conclusions drawn are the result of comparing the computer simulation mode to the long term field data.

1707 Health and Safety

Refer also to citation(s) 51881

20 FOSSIL-FUELED POWER PLANTS

50756 (HQ–CE03147) **Hydro Quebec's Technology, International Affairs and Research Institute Division. Report of activities, 1989.** Hydro-Quebec, Montreal, PQ (Canada). 1989. 74p. (CE–03147). Source: Hydro-Quebec, Centre de diffusion, 75, boul. Dorchester ouest, 14e etage, Montreal, PQ, CAN H2Z 1A4. Prices: N/C.

The TAI (Technology, International Affairs and Research Institute) division of Hydro Quebec has a mandate to conduct research, tests, and development and demonstration work in the areas of power generation, transmission and distribution, along with industrial applications of electricity. TAI activities cover electrical apparatus, cables, overhead lines, internal and external insulation, mechanical engineering, electronics, materials chemistry and technology, power system simulation and analysis, and industrial electrotechnologies. TAI also markets, either alone or with outside partners, some of the products developed at its laboratories, and is responsible for planning Hydro-Quebec's future technological development. The utility's expertise is made available to some 25 countries around the world through its subsidiary, Hydro-Quebec International. Highlights of 1989 activities include the carrying out of some 500 research and development projects and the fulfillment of over 300 testing contracts. New facilities completed or under way include a high-voltage underground cable test facility and an electric/magnetic field demonstration centre. Tests were performed on extra-high-voltage dc cables, optical fibers in overhead wires, and the effect of freezing rain and snow on transmission line insulation. Long term projects are outlined in the areas of superconductivity, catalytic conversion of methane, telerobotics, and magnetic fusion. 30 figs.

2001 Power Plants and Power Generation

Refer also to citation(s) 50368, 50751, 51105, 51611

50757 (CONF-9004133–5) **Estimating the effect of generating unit age on heat rates for coal-fired steam units operating between 1964 and 1981.** Corio, M.R. (Applied Economic Research Co., Inc., New York, NY (USA)); South, D.W.; Stokes, H.H. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From American power conference; Chicago, IL (USA); 23-25 Apr 1990. Order Number DE90017690. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper highlights the heat rate results from phase 1 of a study conducted for the US Department of Energy, wherein we estimated the effect of age on various performance indices associated with the US population of coal-fired steam generating units. In the study, techno-economic relationships between age and (1) equivalent forced outage rate (EFOR), (2) equivalent availability factor (EAF), and (3) heat rate were estimated with time series, cross-sectional econometric models for the period 1964–1981. The effects of age on EFOR and EAF were found to be significant. Although the effects on heat rate vary by the operating and design characteristics of the unit, some general patterns can be seen. For subcritical units, heat rates increase at a decreasing rate as the unit gets older. The increase became greater as the psi of the unit went down. For supercritical units, heat rates initially improve (i.e., go down), although at a decreasing rate, until age 14. After age 14, heat rates start to increase, at an increasing rate, finally reaching their startling levels by age 20. By age 26, heat rates have increased over starting values by 529 Btu/kWh. 2 refs., 2 figs.

50758 (DOE/CE/15453–T4) **Particle densitometer based on the acoustical resonance measurement: Fourth quarterly progress report.** Vetter, A.A. Humbug Mountain Research Labs., Duarte, CA (USA). 1 Oct 1990. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15453. (HMRL-R–73:4). Order Number DE91000251. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Work continued on development of a particle densitometer based on the Acoustical Resonance Measurement to monitor pneumatically conveyed particle mass loading. During this quarter, the closed-loop test system was used for testing and an open-loop test system was constructed. 3 figs.

50759 (EUR–12423) **Utilization of waste heat from power stations: Proceedings.** Cornet d'Elzius, C. (Ministerie van Landsverdediging, Brussels (Belgium)); Ferrero, G.L.; Kocsis, K. Commission of the European Communities, Luxembourg (Luxembourg). Directorate General Telecommunications, Information Industries and Innovation. 1989. 257p. (In English, French). Sponsored by Commission of the European Communities. (CONF-890327–: Seminar on the utilization of low temperature waste heat from power stations, Gembloux (Belgium), 13-15 Mar 1989). Source: NTIS (US Sales Only), PC A12/MF A01; OSTI; Office for Official Publications of the European Communities, 2, rue Mercier, L-2985 Luxembourg; Price ECU 21.25.

Waste heat from power stations represents a source of energy which is little used at the present time. Put to judicious use, this source could produce appreciable energy savings. Individual uses of this heat have already confirmed the validity of upgrading technologies and enabled economic operating balances to be established. Before undertaking new projects in this sector, however, the time has come to learn from the experience gained, to verify the economic and energy balances and to compare the problems encountered and the solutions found. This was the aim of the seminar organized jointly by the Directorate-General for Energy of the Commission of the European Communities, the European Cooperation Networks for Agriculture and Energy of the United Nations Food and Agriculture Organization (FAO) and Recherche Agronomique de Belgique (Agricultural Research Institute in Belgium). The seminar has allowed us to take stock of the state of the art of the technologies employed and their economic viability, and thus helped to formulate conclusions and recommendations to guide future activities in this sector, especially those connected with demonstration and commercial exploitation projects. The seminar was limited to the use of low-temperature waste heat from power stations with a power greater than 100 MW. The use of steam or high-temperature hot water was thus not included..

50760 (Juel-Spez–544) **SIKADE-2: A computer code to simulate dynamics of gas-fired steam generators. Description and user aid.** Meister, G. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung. Dec 1989.

103p. (In German). Order Number DE91712374. Source: NTIS (US Sales Only), PC A06/MF A01.

The mathematical model on which the program is based is made up of a system of coupled partial differential equations in space and time. The equations for the fluid dynamics are in one dimensional space, the fluid variables are therefore averages taken across the channel cross section. The heat transfer in the walls will be described by a two dimensional heat flow equation. This describes both the transverse and the axial heat diffusion in the boiler pipes. The fluid dynamic equations in both flow channels are coupled using the heat transfer equation for the wall by heat transfer correlations. The two-phase flow is modelled by a system of differential equations which demonstrate the continuity rules for mass, energy and impulse. The in principle extensive model was made up of a system of 6 coupled partial differential equations each with one set out of the two continuity equations for each of the two phases. Each equation pair must be coupled by phase transfer coefficients which describe the exchange of mass, energy and impulse between the two phases. Since the gain of mass, energy or impulse in one phase results in the loss in another phase oppose each other, these transfer coefficients in the equation pairs have the same absolute value but the opposite sign. If the sum of the mass, energy and impulse equations for both phases is found, the transfer coefficients cancel out. The summed equations are known as mixed equations and have practical advantages for the numerical integration since they are quite simple. The original equation system is mathematically the equivalent of a system made up of three mixed equations plus one of each of the two phase equations. (orig.).

50761 Digital model power system. Esztergalyos, J. (Bonneville Power Administration, Portland, OR (US)); Nordstrom, J.; Short, T.H.; Martin, K. *IEEE Computer Applications and Power (USA)*, 3(3): 19-24 (Jul 1990).

This article presents a new method for reproducing in the laboratory actual faults that have occurred in the field, and generating worst case fault waveshapes for the actual lines being protected. The key to this method is to reproduce digitally faults or system disturbances that caused undesired or unexplained results in the protection scheme. These faults can then be replayed through amplifiers and applied to the control and protection devices. Changes to settings or logic schemes can be implemented, and field data applied to the protection system located in the laboratory. The tested equipment can then be installed in the operating system with a high degree of confidence.

2002 Waste Management

Refer also to citation(s) 50333, 50775, 51105

50762 (CONF-891185–1, pp. 20, Paper 20) **Global climate change: A fossil energy perspective.** Kane, R.L. (Dept. of Energy, Washington, DC (USA)); South, D.W. East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper is in outline form and presents numerous graphs and tables showing the increase in atmospheric carbon dioxide associated with burning of fossil-fuels. It presents information on relative contributions of carbon dioxide from the world's industrialized countries along with comparative charts of relative contribution to each different fossil-fuel source. It goes on to emphasize the use of clean coal technology and the efficiencies which can be obtained by proper use of pollution control equipment. It also presents a summary of research currently underway by the U.S. Department of Energy to further reduce the amounts of greenhouse gases while enhancing the combustion efficiency of fossil-fired generators.

50763 (DOE/PC/79855–T10) **Simultaneous particulates, NO_x, SO_x removal from flue gas by all solid-state electrochemical technology: Final report, July 15, 1987–January 31, 1990.** Cook, W.J. (Helipump Corp., Cleveland, OH (USA)); Cornell, L.P.; Keyvani, M.; Neyman, M.; Helfritch, D.J. Helipump Corp., Cleveland, OH (USA); Research-Cottrell, Inc., Somerville, NJ (USA). Environmental Services and Technologies Div. 17 Apr 1990. 88p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79855. Order Number DE91000002. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The process control SO_x, NO_x, and particulate emission from coal combustion flue gases. It is based on a solid-state, electrochemical reactor which converts NO_x and SO_2 to nitrogen, sulfur, and oxygen. Sulfur is condensed downstream at a lower temperature. Particulates are removed with a filter or electrostatic precipitator. The process utilizes no other material input (flue gas is the only fluid), has no moving parts, and produces no sludge(s). The reactor consists of an electrochemical cell where the electrolyte is a solid oxygen ion conducting ceramic such as stabilized ceria or zirconia and the electrodes are electronically conductive material(s). Porous metal such as silver or gold were used as electrodes in the experimental work. Acceptable reduction rates and electric power requirements for sulfur dioxide and nitrogen oxide removal were obtained in up to 1% oxygen with ruthenium and strontium ruthenate electrocatalysts. Electrocatalytic improvements are needed for higher oxygen concentrations, with the NO reduction rates and efficiencies being most sensitive to oxygen concentration. The best electrocatalysts were ruthenium and the perovskite strontium ruthenate. 37 refs., 23 figs., 26 tabs.

50764 (DOE/PC/88873–T5-Vol.1) **Global approach for enhanced mass transfer effects in-duct flue gas desulfurization processes: Work plan: Volume 1, Literature review.** Energy and Environmental Research Corp., Irvine, CA (USA). 1 Oct 1988. 107p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88873. Order Number DE90017881. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This document is a review of the available literature pertaining to induct SO_2 capture. While it attempts to present the data and conclusions of the most recent and most important experimental studies on the subject, the following sections actually go much farther. EER's current model for in-duct capture is applied to a synthesis of the existing database in Section 3.0. A review is also provided of the various physical, chemical, thermodynamic and transport properties which must be considered when modeling induct capture. These are provided in Section 4.0. A review of other process models is presented in Section 5.0. Finally, Section 6.0 attempts to define the gaps in the existing database and identify the research needs which must be fulfilled in order to advance the current understanding of in-duct capture toward predictive modeling and process optimization. 69 refs., 30 figs., 17 tabs.

50765 (DOE/PC/88873–T5-Vol.2) **Global approach for enhanced mass transfer effects in-duct flue gas desulfurization processes: Work plan: Volume 2, Test plan and schedule.** Energy and Environmental Research Corp., Irvine, CA (USA). 1 Oct 1988. 107p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88873. Order Number DE90017882. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The duct injection process for flue gas desulfurization offers the promise of a low-cost SO_2 control technology which can be retrofitted to coal fired power plants. The cost effectiveness of this technology is almost directly proportional to the sorbent utilization. Thus, an overriding objective of this program is to identify the maximum sorbent utilization attainable with high SO_2 removal. The program plan includes: determine the controlling physical and chemical processes which limit sorbent utilization. In particular the proposed experiments will determine whether mass transfer is a controlling factor in induct FGD and establish the relative contributions of gas and liquid phase mass transfer and inherent sorbent reactivity; and (2) examine various techniques which will enable sorbent utilization rates of at least 75 percent to be achieved. The program has been designed to address both slurry and dry injection processes as well as quantifying the importance of capture occurring in a baghouse. The overall approach is a combination of carefully controlled fundamental experimental studies, theoretical analyses with computer simulation, and experimental studies, theoretical analyses with computer simulation, and experimental measurements in a small pilot-scale simulator. 26 figs., 5 tabs.

50766 (DOE/PC/88873–T6-Vol.1) **Global approach for enhanced mass transfer effects in-duct flue gas desulfurization processes: Work plan: Volume 1, Literature review.** Energy and Environmental Research Corp., Irvine, CA (USA). 1 Oct 1988. 106p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88873. Order Number DE90017896. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

40This document is a review of the available literature pertaining to induct SO_2 capture. While it attempts to present the data and conclusions of the most recent and most important experimental studies on the subject, the following sections actually go much farther. EER's current model for in-duct capture is applied to a synthesis of the existing database in Section 3.0. A review is also provided of the various physical, chemical, thermodynamic and transport properties which must be considered when modeling in-duct capture. These are provided in Section 4.0. A review of other process models is presented in Section 5.0. Finally, Section 6.0 attempts to define the gaps in the existing database and identify the research needs which must be fulfilled in order to advance the current understanding of in-duct capture toward predictive modeling and process optimization. 70 refs., 30 figs., 17 tabs.

50767 (DOE/PC/88873–T7) **Global approach for enhanced mass transfer effects: In-duct injection FGD processes: Topical report No. 1, Experimental studies.** Energy and Environmental Research Corp., Irvine, CA (USA). May 1990. 37p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88873. Order Number DE91000589. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This topical report describes the experimental results from a global investigation of in-duct SO_2 capture by lime-slurry sprays. To large extent the experiments were guided by a parallel model-development effort. The data were used to test and refine various assumptions made by the model about internal vs. external mass transfer, temperature, humidity, SO_2 concentration and slurry concentration. Also, the experiments performed a scoping function for the overall DOE duct injection program. By testing lime slurry sprays for SO_2 capture over a range of conditions, this program has identified limits and variabilities of sorbent performance which may be encountered in future pilot – and demonstration – scale tests. A significant fraction of the experimental effort was applied to a continual evolution of the system design. This evolution of design was a response to the changing needs of the program. Aspects which were especially critical were the slurry atomizer design, the sampling system, and control of the complete reactor environment, including temperature, humidity, and gas composition. 18 figs., 3 tabs.

50768 (EPRI-GS–6963-Vol.1) **Proceedings: 1990 SO_2 control symposium: Volume 1: Sessions 1, 2, 3A, 3B, and 4A.** Electric Power Research Inst., Palo Alto, CA (USA). ©Sep 1990. 673p. Sponsored by Electric Power Research Institute. (CONF-900524–Vol.1: 1990 SO_2 control symposium, New Orleans, LA (USA), 8-11 May 1990). Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

These proceedings are of The 1990 SO_2 Control Symposium held in New Orleans, Louisiana, from May 8 through May 11. The objective of the Symposium was to provide a forum for the exchange of technical and regulatory information on sulfur oxide control technology, including wet and dry scrubbing, emerging processes, and international developments in clean coal/acid rain technologies. Specific topics covered during the Symposium included: SO_2 control economics, furnace sorbent injection, byproduct utilization, spray dryer technology, wet FGD reliability and full scale operation, combined SO_x/NO_x technologies, vendor designs, post-combustion dry injection, and laboratory/pilot research. The audience included approximately 800 representatives from electric utilities, government agencies, industrial users of FGD, academia, consultants, process suppliers, equipment manufacturers, and R&D firms. The topics are presented in volumes. This is volume I which covers international overview, economics, furnace sorbent injection, by-product utilization, and FSI recycle. Individual projects are processed separately for the databases.

50769 (EPRI-GS–6963-Vol.2) **Proceedings: 1990 SO_2 control symposium: Volume 2, Sessions 4B, 4C, 5, and 6A.** Electric Power Research Inst., Palo Alto, CA (USA). ©Sep 1990. 553p. Sponsored by Electric Power Research Institute. (CONF-900524–Vol.2: 1990 SO_2 control symposium, New Orleans, LA (USA), 8-11 May 1990). Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

These proceedings are of The 1990 SO_2 Control Symposium held in New Orleans, Louisiana, from May 8 through May 11. The objective of the Symposium was to provide a forum for the exchange of technical and regulatory information on sulfur oxide control technology, including wet and dry scrubbing, emerging processes, and international developments in clean coal/acid rain technologies. Specific topics covered during the Symposium included: SO_2 control economics, furnace sorbent injection, byproduct utilization, spray dryer technology, wet FGD reliability and full scale operation, combined SO_x/NO_x technologies, vendor designs, post-combustion dry injection, and laboratory/pilot research. The audience included approximately 800 representatives from electric utilities, government agencies, industrial users of FGD, academia, consultants, process suppliers, equipment manufacturers, and R&D firms. The projects are presented in volumes. This report is Volume II and covers wet FGD reliability, spray dryers, and wet full scale operation. Individual projects are processed separately for the data bases. (CBS)

50770 (EPRI-GS–6963-Vol.3) **Proceedings: 1990 SO_2 control symposium: Volume 3, Sessions 6B, 6C, 7A, 7B, and poster.** Electric Power Research Inst., Palo Alto, CA (USA). ©Sep 1990. 831p. Sponsored by Electric Power Research Institute. (CONF-900524–Vol.3: 1990 SO_2 control symposium, New Orleans, LA (USA), 8-11 May 1990). Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

These proceedings are of the 1990 SO_2 Control Symposium held in New Orleans Louisiana from May 8 through May 11. The objective of the Symposium was to provide a forum for the exchange of technical and regulatory information on sulfur oxide control technology, including wet and dry scrubbing, emerging processes, and international developments in clean coal/acid rain technologies. Specific topics covered during the Symposium included: SO_2 control economics, furnace sorbent injection, byproduct utilization, spray dryer technology, wet FGD reliability and full scale operation, combined SO_x/NO_x technologies, vendor designs, post-combustion dry injection, and laboratory/pilot research. The audience included approximately 800 representatives from electric utilities, government agencies, industrial users of FGD, academia, consultants, process suppliers, equipment manufacturers, and R&D firms. The projects are presented in volumes. This report is volume III and covers combined SO_xNO_x processes, wet FGD vendor designs, post combustion dry technologies, and wet FGD research. Individual projects are processed separately for the data bases.

50771 (Juel–2351) **Investigations of the activity reduction of DENOX-catalysts.** Karanatsios, I. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Chemische Technologie der Nuklearen Entsorgung; Technische Hochschule Aachen (Germany, F.R.). Mar 1990. 144p. (In German). Order Number DE91705963. Source: NTIS (US Sales Only), PC A07/MF A01.

The combustion of fossil fuels for energy purposes contributes considerably to the environmental overloading emission of NO_x. It is therefore necessary to introduce NO_x emission controlling measures, concerning the combustion (primary measures) as well as the post-combustion side (secondary measures). This work deals with the selective catalytic reduction of NO_x with NH_3 without dust separation - 'high dust' technique - and investigates the activity of iron oxide catalysts. Experiments at a DENOX pilot plant after a wet-bottom coal boiler with dust recirculation, showed within 1500 h a reduction of the catalytic activity up to 10% of the initial value. The activity remained then constant. This activity reduction cannot be ascribed to the dust. The chemical analysis of the catalysts, by means of XRF and NAA, showed a strong enrichment of the elements As, Mo, Sb and Tl. Arsenic was much more strongly enriched than the other elements. This relation of the activity reduction to the arsenic concentration indicates chemical poisoning of the catalyst material. Experiments with a laboratory apparatus confirmed the above indication. A number of iron oxide catalysts was loaded with gaseous arsenic trioxide till they were saturated.

The saturated catalysts had an activity rest up to 10-30% of the initial activity. The value of this activity rest is proportional to the specific surface value of the catalyst. Arsenic trioxide is chemically adsorbed on the active sides of the catalyst, as SEM analysis showed, in the form of an amorphous compound. ESCA measurements indicated the formation of arsenites on the surface of the catalysts. (orig.).

50772 (KFK-PEF–67) **Pulsed electrostatic precipitators to enhance dust precipitation.** Hinderer, A. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Elektroenergiesysteme und Hochspannungstechnik); Schwab, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). May 1990. 182p. (In German). Contract PEF 87/003/3. Order Number DE91706243. Source: NTIS (US Sales Only), PC A09/MF A01.

Improved precipitation efficiency of electrostatic precipitators, regarding high-ohmic dust prone to cause back corona, is expected from the superposition of high-voltage impulses to the direct voltage normally used. However, as contradictory demands must be met by choosing suitable energization parameters, the question must be answered of which forms, amplitudes, and repetition rates of impulses are suited, and which is the appropriate combination of basic dc voltage and superimposed impulses in order to optimize the precipitation efficiency. In this project, some precipitation processes in electrostatic precipitators were simulated. Individual relationships were verified by measurements. Some criteria for optimizing precipitation, in other words, for avoiding back corona, were derived from simulations and measurements. These permit to take into account effects of the waveform, amplitude and repetition rate of the pulses. Specific cases require own simulations. (orig.) With 149 figs., 50 refs.

50773 (LBL–27595) **The use of wet limestone systems for combined removal of SO_2 and NO_x from flue gas.** Lee, G.C. (Bechtel Corp., San Francisco, CA (USA)); Shen, D.X.; Littlejohn, D.; Chang, S.G. Lawrence Berkeley Lab., CA (USA). Mar 1990. 25p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC03-76SF00098. (CONF-900524–1: 1990 SO_2 control symposium, New Orleans, LA (USA), 8-11 May 1990). Order Number DE91000224. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new approach by utilizing yellow phosphorus in conventional wet limestone systems for high efficiency control of SO_2 and NO_x emissions from power plants has been developed. The addition of yellow phosphorus in the system induces the production of O_3 which subsequently oxidizes NO to NO_2. The resulting NO_2 dissolves readily and can be reduced to form ammonium ions by dissolved SO_2 under appropriate conditions. Yellow phosphorus is oxidized to yield P_2O_5 which picks up water to form H_3PO_4 mists and can be collected as a valuable product. Proof of concept experiments have been performed using a 20 acfm bench-scale system. The results show that better than 90% of SO_2 and NO in simulated flue gas can be removed. Stoichiometric ratios (P/NO) ranging between 0.6 and 1.5 were obtained. This ratio depends on operating conditions as well as the process configuration. A conceptual process flow diagram has been proposed. A preliminary cost evaluation of this approach appears to indicate great economic potential. 22 refs., 8 figs., 1 tab.

2005 Environmental Aspects

Refer also to citation(s) 50778, 50779, 51027, 51741

50774 (NBE–90-03330) **Draft guidelines for an environmental impact assessment: N.B Power - Millbank generating station.** New Brunswick Dept. of the Environment, Fredericton, NB (Canada). 1 Mar 1990. 27p. (MICROLOG–90-03330). Source: PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper identifies important environmental issues arising from the proposal by the New Brunswick Electric Power Company (N.B. Power) to construct and operate a combustion turbine generating station with a nominal capacity of 400 MW, at Millbank, N.B. This proposed facility, which will burn low sulphur diesel oil (0.5%), is expected to operate for approximately 500 hours per year to provide peaking capacity for both domestic use and for export. These guidelines will provide a general framework for conducting an Environmental Impact Assessment (EIA). The EIA process results in a detailed study of potential environmental impacts and methods which may be used to control these effects. This paper outlines the methodological approach and how to prepare and present an EIA with reference to project description, existing environment description, identification and analysis of alternatives, project rationale, a terms of reference and the significant issues which will help determine the impacts of the proposed project.

50775 (NSE–90-04599) **Report and recommendations on the Nova Scotia Power Corporation, Point Aconi generating station.** Nova Scotia Ministry of the Environment, Halifax, NS (Canada). 23 Feb 1990. 22p. (MICROLOG–90-04599). Source: PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A project has been proposed to construct a 165 MW power station at a seaside site near Point Aconi, Nova Scotia. The plant will burn local high-sulfur coal in a circulating fluidized-bed combustor. An environmental assessment review was conducted to consider various issues related to the impacts of the proposed plant. Following a description of the various components of the power plant (combustor, coal/limestone delivery and storage, waste management, water supply, and cooling systems), the issues arising during the review process are discussed. These include the need for the plant, carbon dioxide emissions, sulfur dioxide capture, coal dust control, effects of the water circulation system on local fisheries, effects on local fresh water supplies, ash disposal, access to local beaches, and impact on local traffic.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50368, 50370, 50371, 50372, 50744, 50940, 51027

50776 Supplying electricity through greater efficiency. Meier, A. (Lawrence Berkeley Lab., CA (USA)). pp. 139-142 of Fueling the 21st century. Sheindlin, A.E.; Zaleski, P. Hemisphere Publishing, New York, NY (USA) (1989). pp. 860

This paper discusses the goal of making electricity conservation options as comparable as possible to electricity supply options. Factors affecting comparisons are listed.

2007 Legislation and Regulations

Refer also to citation(s) 51027

50777 (D–90-5) **City of Medicine Hat power plant expansion: Decision 90-5.** Energy Resources Conservation Board, Calgary, AB (Canada). 1989. 30p. (CE–03153). Source: Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: PRICES UPON REQUEST.

A hearing was held to consider issues related to an application for approvals to construct, connect, and operate an expansion to the existing power plant at Medicine Hat, Alberta. The expansion would consist of two 17-MW gas turbine generators and associated heat recovery boilers, and one 30-MW steam turbine generator. The issues considered at the hearing were the technical and environmental merits of the proposed expansion, the meaning and importance of coordinated planning with the rest of Alberta's electric power system, the need for the plant and its timing, and the economics of the various options. It was felt that the phased nature of the expansion, to be carried out in 2 stages and completed by 1996, lends itself to providing flexibility in planning future additions to the provincial system provided it can be integrated into a single provincial plan. It was agreed that the expansion would increase operating efficiency and lower overall emissions, thus the expansion was found to be technically and environmentally acceptable. It was also felt that the city power system should be integrated into

the provincial power planning process. There is a current surplus of capacity on the Alberta Interconnected System, likely to persist until 1993, and there is a potential economic benefit of deferring the proposed expansion for up to 3 years and supplying the city with reserve capacity from the interconnected system. The application for the expansion was therefore denied at this time, and it was recommended that an agreement between the city and the interconnected system be pursued. 2 figs., 6 tabs.

50778 (NSE–90-03279) **Report and recommendations to the minister regarding the environmental assessment report for the proposed Point Aconi electical generating station.** Nova Scotia Ministry of the Environment, Halifax, NS (Canada). 23 Feb 1990. 121p. (MICROLOG–90-03279). Source: PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Nova Scotia Power Corporation announced plans to build a 165 MW generating station at Point Aconi, Nova Scotia using circulating fluidized bed combustion technology. The Nova Scotia Environmental Control Council held public hearings at which oral and written submissions were received, and numerous relevant reports and articles were studied. This report presents the recommendations of the Council, which approved the station, based on concerns raised at the hearings. Concerns of residents included the use of alternative technologies for power generation, management of liquid and solid wastes, fuel and sorbent management, fresh water supply, air quality, general construction practices, and establishing a local monitoring committee. In addition, concerns were expressed on the hearing procedures, the time limits for response by intervenors, intervenor funding, and the acts and regulations under which the public hearings were held.

50779 (SDC–90-664) **Point Aconi public consultation meetings: Electrical generating station proposal: Complete verbatim transcript.** Nova Scotia Ministry of the Environment, Halifax, NS (Canada). 1990. 240p. (MICROLOG–90-03278). Source: PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This is a complete vertabum transcript of public hearings, held by the Nova Scotia Environment Control Council, on the proposed construction of a circulating fluidized bed coal-fired generating station at Point Aconi, Nova Scotia, by the Nova Scotia Power Corporation (NSPC). The meetings began with a brief description of the proposal and the legislation which necessitated public hearings. Presentations by NSPC focussed on the generation capacity of the proposed plant and the environmental impacts considered by the company. Interested parties gave submissions, and questions for NSPC were fielded through the Chair of the hearings. The three meetings were held with essentially the same format. Topics addressed included alternatives to the station, the format of and restrictions on the hearings, long-term effects on the climate due to carbon dioxide emissions, changes in the water table, the market for the electrical power produced, waste disposal, and the environmental impact of the transmission corridor.

21 NUCLEAR POWER PLANTS

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 50834, 50842, 50879, 50881, 50885, 50887, 50890

50780 (IAE–4673-4) **Use of the volume compensator elastic properties for increasing the stability of coolant natural circulation in sub-boiling plants.** Leshik, P.A.; Kobzar', L.L.; Zaval'skij, V.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 21p. (In Russian). Order Number DE91604652. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Theoretical premises are considered for a method of improving the stability of coolant natural circulation in sub-boiling apparatus which is based on the decreasing compressibility of medium in the volume compensator and the steam condensation at the draft section outlet below liquid level. The efficiency of such a method is confirmed by the results of experiments on a large-scale thermohydraulic model of the AST-500 reactor primary circuit. 7 refs.; 11 figs.; 1 tab.

50781 (NUREG/CR–4469-Vol.10) **Nondestructive examination (NDE) reliability for inservice inspection of light water reactors: Semi-annual report, October 1988–March 1989.** Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Deffenbaugh, J.D.; Good, M.S.; Green, E.R.; Heasler, P.G.; Simonen, F.A.; Spanner, J.C.; Taylor, T.T.; Vo, T.V. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 91p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–5711-Vol.10). Source: NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

The Evaluation and Improvement of NDE Reliability for Inservice Inspection of Light Water Reactors (NDE Reliability) Program at the Pacific Northwest Laboratory was established by the Nuclear Regulatory Commission to determine the reliability of current inservice inspection (ISI) techniques and to develop recommendations that will ensure a suitably high inspection reliability. The objectives of this program include determining the reliability of ISI performed on the primary systems of commercial light-water reactors (LWRs); using probabilistic fracture mechanics analysis to determine the impact of NDE unreliability on system safety; and evaluating reliability improvements that can be achieved with improved and advanced technology. A final objective is to formulate recommended revisions to ASME Code and Regulatory requirements, based on material properties, service conditions, and NDE uncertainties. The program scope is limited to ISI of the primary systems including the piping, vessel, and other components inspected in accordance with Section XI of the ASME Code. This is a progress report covering the programmatic work from October 1988 through March 1989. 8 refs., 15 figs., 19 tabs.

50782 (ORNL/FTR–3738) **[Fracture mechanics of inhomogeneous materials]: Foreign trip report, August 31, 1990–September 16, 1990.** Bass, B.R. Oak Ridge National Lab., TN (USA). 1 Oct 1990. 16p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE91000690. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Discussions were held with Japanese researchers concerning (1) the Elastic-Plastic Fracture Mechanics in Inhomogeneous Materials and Structures (EPI) Program, and (2) ongoing large-scale pressurized- thermal-shock (PTS) experiments in Japan. In the EPI Program, major activities in the current fiscal year include round-robin analyses of measured data from inhomogeneous base metal/weld metal compact- tension (CT) specimens fabricated from welded plates of A533 grade B class 1 steel. The round-robin task involves participants from nine research organizations in Japan and is scheduled for completion by the end of 1990. Additional experiments will be performed on crack growth in inhomogeneous CT specimens and three-point bend (3PB) specimens 10 mm thick. The data will be compared with that generated previously from 19-mm-thick-specimens. A new type of inhomogeneous surface-cracked specimen will be tested this year, with ratio of crack depth to surface length (a/c) satisfying $0.2 \leq (a/c) \leq 0.8$ and using a 3PB type of applied load. Plans are under way to fabricate a new welded plate of A533 grade B class 1 steel (from a different heat than that currently being tested) in order to provide an expanded fracture-toughness data base. Other topics concerning fracture-prevention issues in reactor pressure vessels were discussed with each of the host organizations, including an overview of ongoing work in the Heavy-Section Steel Technology (HSST) Program.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 50602, 50781, 50782, 50820, 50834, 50842, 50876, 50878, 50879, 50882, 50885, 50886, 50887, 50890

50783 (DOE/NE/34082–1) **TRIBULATION [Tests Relative to High BUrnup Limitations Arising from Transient Incidents Occurring Normally] Project: Final report.** Lippens, M.; Boulanger, D. Belgonucleaire S.A., Brussels (Belgium). Oct 1990. 75p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract FG01-82NE34082. Order Number DE90016400. Source: NTIS (US Sales Only), PC A11/MF A01 - OSTI; GPO Dep.

The programme TRIBULATION was started on July 1st, 1980. It was jointly organized by CEN/SCK (Centre d'Etude de l'Energie Nucleaire/Studiecentrum voor kernenergie) and BN (BELGONUCLEAIRE), and was co-sponsored by fourteen participants including Fuel Vendors, Utilities, Nuclear Centres and National Authorities. The objectives of the TRIBULATION programme were twofold. It was primarily a demonstration programme related to the fuel rod behaviour which might be expected at high burn-up, when an earlier transient has occurred in the power plant. These transients were carried out in an experimental device in the BR2 MTR (MOL, Belgium) and simulated events classified in "condition II" (incidents of moderate frequency, i.e. once a year) by the ANSI "Nuclear Safety Criteria for the Design of Stationary PWR Plants." This objective was complemented by a second goal to investigate, after steady state irradiation, high burn-up behaviour of a broad variety of fuel rods representing various designs and fuel fabrication processes. The document provides a discussion of the program and its results.

50784 (JAERI-M–90-091) **Technical report: fabrication of PWR type rodlet fuel.** Yanagisawa, Kazuaki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Uno, Hisao; Sasajima, Hideo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 183p. (In Japanese). Order Number DE91713042. Source: NTIS (US Sales Only), PC A09/MF A01.

With respect to the simulated reactivity initiated accident (RIA) experiments with pre-irradiated LWR type fuel rods at nuclear safety research reactor (NSRR), there were principally three technical difficulties which should be overcome: (1) Fabrication of the rodlet fuel; Fuel rods from the commercial power reactors had an active column length by 3.6m. To utilize this for NSRR pulse experiment, rodlet fuel having an active column length by 0.12m (reduced to one thirtieth) is requested to fabricate without changing the inside fuel conditions. (2) Development of in-core instrumentations: During pre-irradiation stages, a long-sized fuel rod had dimensional changes by waterside corrosion, bowing, creep down and so on. The fuel also had greater amount of radioactive fission products. This condition is significant to in-core instrumentations to be attached to the fuel rods. Well characterized data to be obtained from these, however, are quite necessary and important from research point of view. Remote handling techniques to attach the rod pressure sensor, the cladding extensometer, the fuel extensometer, and the cladding surface thermocouple to pre-irradiated fuel rods are, therefore, requested to develop. (3) Installation of PIE equipments for pulsed rodlet fuels: PIE on the pulsed rodlet fuels are necessary to better understanding the fuel performance detaily. Equipments which can easily detect the data related to PCMI type fuel failure are matter of concern. Since 1986, the technical difficulties have been tried to overcome by all staffs belonging to Reactivity Accident Laboratory, NSRR Operation Division, Department of Reactor Fuel Examination and Hot Laboratory. This report describes the technical achievements obtained through four years work. (author).

50785 (NUREG/CR–5530) **Analysis of H.B. Robinson PWR vessel fluence for cycle 10 utilizing partial length shield assemblies.** Williams, M.L. (Louisiana State Univ., Baton Rouge, LA (USA). Nuclear Science Center); Asgari, M.; Childs, R.L. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Sep 1990. 92p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11476). Source: NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Neutron transport calculations have been performed to determine the pressure vessel fluence and cavity dosimeter responses for cycle 10 of the H. B. Robinson pressurized water reactor. This cycle was the first to utilize "partial length shield assemblies" within the core to reduce the fluence rate at the critical weld location in the vessel. This work is part of the ongoing surveillance of the Robinson plant to insure that the projected fluence rates of reliable. The flux calculations utilize a "two-channel" synthesis approximation and recently processed iron cross sections based on new evaluation for the inelastic data above 3 MeV. The methodology used to calculate this highly asymmetrical configuration is discussed in detail, and a comparison of the calculated and measured cavity-dosimetry results is presented. Discrepancies are observed in the computed and measured results for the ^{237}Np dosimeter, and possible explanations are discussed. Calculated absolute neutron flux spectra, as well as radial, azimuthal, and axial variations in the fast flux and dpa within the pressure vessel, are given. The effect of a least-squares consolidation of the measured calculated results is studied. 12 refs., 27 figs., 36 tabs.

50786 (ORNL/FTR–3753) **[Irradiation embrittlement of reactor pressure vessels]: Foreign trip report, August 28–September 9, 1990.** Corwin, W.R. Oak Ridge National Lab., TN (USA). 24 Sep 1990. 22p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE91000382. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler served as a member of the two-man US Nuclear Regulatory Commission sponsored team who visited the Prometey Complex in Leningrad to assess the potential for expanded cooperative research concerning integrity of the primary pressure boundary in commercial light-water reactors. The emphasis was on irradiation embrittlement, structural analysis, and fracture mechanics research for reactor pressure vessels. At the irradiation seminar in Cologne, presentations were made by German, French, Finnish, Russian, and US delegations concerning many aspects of irradiation of pressure vessel steels. The traveler made presentations on mechanisms of irradiation embrittlement and on important aspects of the Heavy-Section Steel Irradiation Program results of irradiated fracture mechanics tests.

50787 (SAND–90-2128C) **Feasibility for development of a nuclear reactor pressure vessel flaw distribution: Sensitivity analyses and NDE [nondestructive evaluation] capability.** Rosinski, S.T. (Sandia National Labs., Albuquerque, NM (USA)); Kennedy, E.L.; Foulds, J.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. (CONF-9010200–1: IAEA specialists meeting on nuclear power plant lifetime assurance, Stockholm (Sweden), 10-13 Oct 1990). Order Number DE91000409. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Pressurized water reactor pressure vessels operate under US Nuclear Regulatory Commission (NRC) rules and regulatory guides that are intended to maintain a low probability of vessel failure. The NRC has also addressed neutron embrittlement of pressurized water reactor pressure vessels by imposing regulations on plant operation. Plants failing to meet the operating criteria specified by these rules and regulations are required, among other things, to analytically demonstrate fitness for service in order to continue safe operation. The initial flaw size or distribution of initial vessel flaws is a key input to the required vessel integrity analyses. A fracture mechanics sensitivity study was performed to quantify the effect of the assumed flaw distribution on the predicted vessel performance under a specified pressurized thermal shock transient and to determine the critical crack size. Results of the analysis indicate that vessel performance in terms of the estimated probability of failure is very sensitive to the assumed flaw distribution. 20 refs., 3 figs., 2 tabs.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 50871, 50872, 50873, 50877, 51241

50788 (JAERI-M–90-048) **DELIGHT-7: one dimensional fuel cell burnup analysis code for High Temperature Gas-cooled Reactors (HTGR).** Shindo, Ryuichi (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Yamashita, Kiyonobu; Murata, Isao. Japan Atomic Energy

Research Inst., Tokyo (Japan). Mar 1990. 231p. (In Japanese). Order Number DE91712914. Source: NTIS (US Sales Only), PC A11/MF A01.

DELIGHT-7 has been developed to analyze the burnup characteristics of block type fuel and ball type fuel used for High Temperature Gas-cooled Reactors (HTGRs). This code can produce the required group constants for HTGR core analysis. This code consists of resonance-, neutron spectrum-, fuel cell-, burnable poison cell-, energy group condensing- and burnup calculations. The double heterogeneity due to coated fuel particle is also considered. This report presents the physical theory used in this code and can be used as user's manual. (author).

50789 (JAERI-M–90-078) **Report of the 1st technical meeting on high temperature gas-cooled reactors.** Japan Atomic Energy Research Inst., Tokyo (Japan). May 1990. 219p. (In Japanese). Order Number DE91712980. Source: NTIS (US Sales Only), PC A10/MF A01.

The 1st Technical Meeting on High Temperature Gas Cooled Reactors (HTGRs) was held on February 1 and 2, 1990 in the Tokai Research Establishment in order to review the results of R and D associated with the High Temperature Engineering Test Reactor (HTTR) accumulated so far in the JAERI and to investigate how to promote the further R and D on high temperature engineering and examination. From the point of view for establishing and upgrading the technology basis of HTGRs, the R and D results obtained so far and the present status of R and D were reviewed for the key items in the meeting, and the R and D items to be investigated positively and items of international cooperation to be promoted in future were discussed based on the comments and suggestions offered by the experts outside the JAERI. This report summarizes the papers which were presented on each subject of R and D in the meeting along with the comments and suggestions by the experts outside the JAERI. The results of the meeting will be reflected effectively for promoting the R and D on the high temperature engineering and examination. (author).

50790 (Juel–2312) **Steam gasification of coal using a pressurized circulating fluidized bed.** Werner, K.F.J. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.). Sep 1989. 130p. (In German). Order Number DE91712356. Source: NTIS (US Sales Only), PC A07/MF A01.

Subject of this investigation is the process engineering of a coal gasification using nuclear heat. A special aspect is the efficiency. To this purpose a new method for calculating the kinetics of hard coal steam gasification in a fluidized bed is presented. It is used for evaluations of gasification kinetics in a large-scale process on the basis of laboratory-scale experiments. The method is verified by experimental data from a large-scale gasifier. The investment costs and the operating costs of the designed process are estimated. (orig.).

50791 (Juel–2359) **Simulation of the THTR-300 referring to transients recorded during the test phase.** Hoffmann, J. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Sicherheitsforschung und Reaktortechnik; Technische Hochschule Aachen (Germany, F.R.). May 1990. 91p. (In German). Order Number DE91712357. Source: NTIS (US Sales Only), PC A05/MF A01.

Following the construction of the THTR-300 measured values describing the behaviour of the whole power plant have been stored on magnetic tapes. Task is now to show that the power plant simulation program ALAMO is able to calculate the behaviour of the THTR-300. Calculations are done for stationary core, normal working power plant with varying power production, fast turbine shutoff and fast shutdown of the reactor. In addition, the helium-flow in the primary circle is explained. Especially the mass of the helium that bypasses the pebble bed is calculated. (orig.).

2104 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated

Refer also to citation(s) 50880

2105 Power Reactors, Breeding

Refer also to citation(s) 50848, 50849

50792 (CONF-900917–16) **Dynamic analysis of the EBR-II plant with the DSNP-ND simulation package.** Madell, J.T. (System Simulation and Analyses, Inc., Western Springs, IL (USA)); Dean, E.M.; Mohr, D.; Hung, T.C. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE90017825. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Development and initial testing have been completed for a special version of the DSNP simulation language software package, DSNP-ND, which simulates EBR-II based on the models of the primary system components used in the NATDEMO program. Preliminary results are included for a comparison with an original NATDEMO prediction for the SHRT-45 transient. 7 refs.

50793 (FEI–1945) **Studying the unsteady conjugated heat exchange when filling a pipeline with liquid metal.** Burakov, B.G.; Kanukhina, S.V.; Ivanova, T.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst. 1988. 24p. (In Russian). Order Number DE91604683. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Unsteady conjugated heat exchange when filling a pipeline with a liquid metal is investigated. A set of two nonstationary differential equations of energy in partial derivatives of the elliptic type for a solid channel wall and for the liquid metal flow is solved. Dynamics of the temperature field in the channel wall and in the liquid flow is obtained. Nusselt numbers Nu are shown to be closer to specification of boundary conditions T=const, than to specification of boundary conditions q=const (T-temperature, q-heat flux). 7 refs.; 16 figs.

50794 (IAE–4656-4) **Comparative analysis of fast reactor dynamics with homogeneous and heterogeneous cores.** Alekseev, P.N. (and others); Buchenkov, A.V.; Vinogradova, E.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 9p. (In Russian). Order Number DE91604684. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Results of comparative analysis of dynamics of large fast reactors with oxide-metallic in-assembly heterogeneous core and traditional homogeneous oxide and metallic cores are presented. Quantitative estimations of permissible accidental reactivity insertions and variations of coolant flow rate that may be used when choosing promising fast reactor concepts are obtained. 6 refs.; 6 figs.

50795 (IAE–4804-4) **Prospective modular reactor with liquid metal coolant.** Alekseev, P.N. (and others); Zverkov, Yu.A.; Morozov, A.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 16p. (In Russian). Order Number DE91604685. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The concept of a reactor plant with a modular liquid-metal cooled fast reactor is considered. The proposed concept realizable at the present-day level of reactor technology development is characterized by a high-degree of safety provided by self-protection and increased fuel breeding based on the intra-assembly heterogeneous arrangement of the reactor core. 10 refs.; 2 tabs.

50796 (IWGFR–65, pp. 38-44) **Seismic design principles for the German fast breeder reactor SNR2.** Rangette, A.M. (Internationale Atomreaktorbau GmbH (INTERATOM), Bergisch Gladbach (Germany, F.R.)); Peters, K.A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The leading aim of a seismic design is, besides protection against seismic impacts, not to enhance the overall risk in the absence of seismic vibrations and, secondly, to avoid competition between operational needs and a seismic structural design. This approach is supported by avoiding overconservatism in the assumption of seismic loads and in the calculation of the structural response. Accordingly the seismic principles are stated as follows: restriction to German or equivalent low seismicity sites with intensities (SSE) lower VIII at frequency lower than 10^{-4}/year; best estimate of seismic input-data without further conservatism; no consideration of OBE. The structural design principles are: 1. The secondary character of the seismic excitation is explicitly accounted for; 2. Energy absorption is allowed for by ductility of materials and construction. Accordingly strain criteria are used for failure predictions instead of stress criteria. (author). 1 fig.

50797 (IWGFR–65, pp. 45-63) **Status report on R and D for seismic analysis of FBR structures in France.** Gantenbein, F. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The French Status Report provided an overview on the numerical and experimental studies performed for SPX-1 on core (partly in co-operation with Italy) shutdown system, buckling of thin shells, etc. and summarized research items in progress for SPX-2 (3D effects including FSI, improvement of core analysis by development and use of 3D codes and tests on new shaking tables, piping analysis, probabilistic methods). It was mentioned that these studies are being performed by France in the framework of the European co-operation on LMFBR development (AGT-9B and AGT-5 groups). Finally, it was pointed out that SPX-2 might be seismically isolated. 20 refs, 13 figs.

50798 (IWGFR–65, pp. 64-85) **Status report on the R and D studies performed in Italy for fast reactor seismic analysis.** Martelli, A. (ENEA, Bologna (Italy). Dipt. Reattori Veloci); Cecchini, F.; Forni, M. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

After some notes on the high levels of the design earthquakes adopted for PEC and the important features of this reactor (making it particularly sensitive to seismic excitation), this paper presents the fundamentals of the numerical and experimental studies that were carried out by ENEA in co-operation with ANSALDO, ISMES and AGIP for the PEC seismic verification. More precisely, the paper focuses on the wide-ranging research and development programme that has been performed (and recently completed) on the reactor building, the reactor-block, the main vessel, the core and the shutdown system. The needs of these detailed studies are stressed and the feed-back on the PEC design, necessary to satisfy the seismic safety requirements, are recalled. The general validity of the analyses in the framework of the research and development activities for fast reactors is also pointed out. Some notes on piping studies and LMFBR component analysis performed in Italy are also contained: in this framework, seismic tests performed on a SPX-1 primary pump shaft in the CPV-1 test rig at the ENEA Center of Brasimone are recalled. (author). 20 refs, 17 figs.

50799 (IWGFR–65, pp. 86-115) **Current status of Japanese R and D on LMFBR seismic design.** Morishita, Masaki (Power Reactor and Nuclear Fuel Development Corp. (Japan)); Ohya, Tetsuo; Sawada, Yoshihiro. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The development of LMFBR in Japan is at the stage where the prototype power plant MONJU is under construction, and design studies are made on large scale demonstration plants. Seismic design is one of the most crucial issues in the safety design of LMFBR in Japan. Therefore, extensive R and D, including numerical methods development and seismic verification tests, were performed in advance of the design and construction of MONJU. An overview of these results are given in the first part of this paper, together with the review of the overall seismic design procedures. Efforts are also made to establish safe, reliable, and economically competitive LMFBRs, among which demonstrating the availability of pool-type design under the severe seismic input in Japan is pursued, through rationalization of seismic design. The current results of these research programs are given in the latter part of this paper. (author). 4 refs, 17 figs, 2 tabs.

50800 (IWGFR–65, pp. 116-120) **Basic requirements on fast reactor seismic stability in the USSR.** Buksha, Yu.K. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.); Vladykov, G.M.; Levshin, E.P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Basic requirements defined by operating regulatory documents used for designing nuclear power plants for seismic regions have been considered. Some specific requirements imposed upon the BN-800 reactor project are presented. (author). 3 refs.

50801 (IWGFR–65, pp. 121-137) **Seismic assessment of fast reactors in the UK.** Dostal, M. (National Nuclear Corp. Ltd., Risley (UK)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper summarises the principal activities in the United Kingdom on aseismic design, analysis and qualification of LMFBR structures, systems and components. The work described has been performed by NNC as a part of CDFR design activities and by UKAEA and CEGB as a part of the fast reactor research programmes. Future programme plants starting from 1987 are also described. (author). 15 refs, 9 figs, 1 tab.

50802 (IWGFR–65, pp. 138-150) **An overview of the U.S. Department of Energy's program for liquid metal reactor seismic technology.** Jetter, R.I. (Energy Technology Engineering Center, Canoga Park, CA (USA)); Seidensticker, R.W. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

During the past decade, the U.S. Department of Energy (DOE) has sponsored the development of seismic design technology in

support of Liquid Metal Reactors (LMR's). This has been accomplished through (1) major projects such as the Fast Flux Test Facility (FFTF) and the Clinch River Breeder Reactor (CRBR), (2) base technology programs and (3) support to the design development of innovative LMR's, SAFR and PRISM. These developments have come in the areas of ground motion definition, soil-structure interaction, seismic isolation, fluid-structure interaction and structural analysis methods and criteria for equipment and components such as piping, reactor core and vessels. The initial developments in seismic design technology by DOE and others were directed toward ensuring that the plant, equipment and components had sufficient seismic resistance to ensure availability after an Operations Basis Earthquake (OBE) and to survive a Safe Shutdown Earthquake (SSE). During this period, the emphasis on conservative design had significant cost impacts. The current focus is directed toward a better understanding of seismic design margins and the development of methods to reduce seismic loads on plant and equipment and to enhance siting flexibility. From this perspective, the DOE is currently reassessing the needs and priorities for future seismic technology development. Coordination with University research programs and ongoing seismic technology development sponsored by other governmental agencies and institutions is an integral part of this planning process. The purpose of this paper is to highlight the current status of DOE's seismic technology program for LMR's and to provide an overview of future areas of interest. (author). 7 refs.

50803 (IWGFR–65, pp. 152-162) **Study on the seismic response of reactor vessel of pool type LMFBR including fluid-structure interaction.** Tanimoto, K. (Mitsubishi Heavy Industries, Ltd., Kobe (Japan)); Ito, T.; Fujita, K.; Kurihara, C.; Sawada, Y.; Sakurai, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The paper presents the seismic response of reactor vessel of pool type LMFBR with fluid-structure interaction. The reactor vessel has bottom support arrangement, the same core support system as Super-Phenix in France. Due to the bottom support arrangement, the level of core support is lower than that of the side support arrangement. So, in this reactor vessel, the displacement of the core top tends to increase because of the core's rocking. In this study, we investigated the vibration and seismic response characteristics of the reactor vessel. Therefore, the seismic experiments were carried out using one-eighth scale model and the seismic response including FSI and sloshing were investigated. From this study, the effect of liquid on the vibration characteristics and the seismic response characteristics of reactor vessel were clarified and sloshing characteristics were also clarified. It was confirmed that FEM analysis with FSI can reproduce the seismic behavior of the reactor vessel and is applicable to seismic design of the pool type LMFBR with bottom support arrangement. (author). 5 refs, 14 figs, 2 tabs.

50804 (IWGFR–65, pp. 163-179) **30 seismic analysis of FBR vessels: Coupling between components and vessels, fluid communications, imperfections.** Gantenbein, F.; Gibert, R.J.; Aita, S.; Durandet, E. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The internal structures of a loop type breeder reactors such as SUPERPHENIX are composed of axisymmetrical shells separated by fluid volumes. Seismic analysis is usually performed by axisymmetric finite element model taking into account fluid structure interaction but the geometry is in fact 3D due to components, small communications between fluid volumes and imperfections in the vessels. The methods to take this 3D behaviour into account are based on Fourier decomposition of the motion and substructuration. They are briefly described in the following chapters. The influence of components and of small communications on a block reactor similar to SPX1 will also be presented. 15 refs, 20 figs.

50805 (IWGFR–65, pp. 180-188) **Methods adopted to account for vessel-core seismic interactions in the PEC analysis.** Maresca, G. (Ansaldo S.p.A., Genoa (Italy)); Forni, M.; Martelli, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

In the PEC reactor a restraint was provided around the core in order to control the top-core displacements under seismic conditions. Clearances between adjacent elements and between the external elements and the core-restraint ring introduce some amount of non-linearity in the seismic motion of the core. On the other hand a linear analysis shows that the core strongly affects the dynamical behaviour of the vessel. Therefore a method was developed by ENEA and Ansaldo to take into account the effects of non-linearities in the decoupled detailed analysis of the core and reactor block. Studies were also performed in order to account for the possibility of influences of fluid coupling on the core vessel interaction. This paper briefly describes the adopted methods and provides an overview of the main results. (author). 2 refs, 6 figs, 1 tab.

50806 (IWGFR–65, pp. 190-204) **Sloshing analysis by the FINAS computer program and its verification with mock-up test of MONJU reactor vessel.** Morishita, M. (Power Reactor and Nuclear Fuel Development Corp., Narita, Ibaraki (Japan)); Iwata, K.; Imazu, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper describes the seismic vibration test and analysis results on the reactor vessel model of MONJU, the prototype LMFBR of Japan, with the emphasis on sloshing behavior of in-vessel liquid. The tests were made using a 1/4 scale plastic model with various configurations, i.e., with and without internal structures, and the characteristics of free-surface sloshing were identified. Dynamic analyses including fluid-structure interactions were performed by the FINAS general-purpose finite element computer program which has been developed by PNC. A satisfactory agreement was seen between the experimental and computed results in terms of natural frequencies, modes, and dynamic transient response of sloshing. (author). 7 refs, 15 figs, 4 tabs.

50807 (IWGFR–65, pp. 205-210) **A study on non-linear sloshing of pool-type LMFBR coolant.** Sekine, K. (Hitachi Ltd., Ibaraki (Japan). Hitachi Works); Yashiro, T.; Sakurai, A.; Sawada, Y. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Seismic resistance is the most important performance required for Japanese Nuclear Power Plants. In the case of LMFBR, sloshing of the liquid sodium in the reactor might be caused during earthquakes. Most studies on the sloshing have been limited to the

small displacement range. In this study, the large displacement sloshing is studied experimentally and analytically. The following are the results: (1) As the maximum impact pressure is produced by the first impact of the water surface to the structure, the first impact can be seen on the design load; (2) Estimation of the impact pressure by using the impact velocity which has been derived by assuming the linearity of sloshing was found to be effective; (3) Propagation of the pressure wave in the water can be estimated by a wave propagation analysis; (4) By using the above-mentioned methods, structural integrity of the plant is evaluated. (author). 3 refs, 9 figs.

50808 (IWGFR–65, pp. 211-222) **Experimental and analytical study on buckling of fluid-coupled structures during a seismic load.** Barthelet, B. (Electricite de France, 75 - Paris (France). Service de la Production Thermique); Combescure, A.; Geoffroy, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Seismic analysis of a liquid metal fast breeder reactor is generally made with a linear dynamic model. The structure response is a combination of modes n=1 for horizontal earthquakes and n=0 for vertical earthquakes. The resulting loading is used for stability calculation on "static equivalent" models. This procedure may not be correct for two main reasons: geometrical defects and large displacements could change significantly the behaviour of the structures; the dynamic buckling pressure could be different from the static buckling pressure. To answer these questions, an experimental and analytical study on buckling of fluid-coupled structures during a seismic load has been performed by Electricite de France, the Commissariat a l'Energie Atomique and the Universite de Compiegne. The experiments are made on semi-spherical and cylindrical shells on a vibrating table; the loading applied to the structures consists of a permanent pressure and of a dynamic pressure due to fluid-structure interaction. The experimental results are presented and compared with the calculations. This study presents four main points: the dynamic pressure does not vary linearly with the shaking-table acceleration; at high acceleration level, the dynamic pressure increases very slowly; the prestress due to permanent pressure can have a significant effect on the eigenfrequencies if the buckling modes are colinear to the vibration modes; for hemispherical shells studied here, the buckling is obtained when the sum of permanent pressure and dynamic pressure is greater than the static buckling pressure; this structure excited with a horizontal motion can have a response in circumferential modes and not only in mode 1 as predicted by the theory of perfect shells. The defects explain the coupling of modes. (author). 9 figs, 6 tabs, 2 photos.

50809 (IWGFR–65, pp. 222-226) **On the dynamic buckling of thin shells.** Combescure, A.; Hoffmann, A.; Homan, R. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The paper describes the experimental results obtained at CEA-DEMT on the seismic buckling of structures filled with fluid. A general tendency is given on all experimental results. The experimental results are analysed by two simple models and the main results are explained. A strategy to design a structure against dynamic buckling is then presented. (author). 7 refs, 7 figs.

50810 (IWGFR–65, pp. 227-232) **A study on the buckling behaviour of pool-type LMFBR vessel.** Sekine, K. (Hitachi Ltd., Ibaraki (Japan). Hitachi Works); Kokubo, K.; Sakurai, A.; Sawada, Y. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Nuclear power plants are required to withstand against severe earthquakes in Japan. It is known that the shear type buckling modes take place for short cylindrical shells like reactor vessels of the pool-type LMFBRs under lateral loads. On the shear type buckling problems, however, a few studies have been done which we performed and obtained the following results. (1) On the shear type buckling, the load carrying capacity decreases gradually with increasing deformation after the buckling occurs, and the imperfection sensitivity is not so serious. (2) On the dynamic buckling, the initiation of buckling is the same as that of static buckling in buckling load. (3) The buckling load is about 30 m/s^2 on the cylindrical body of a reactor vessel with 50 mm thickness and 19.2 mm diameter under a lateral load. (author). 3 refs, 13 figs, 1 tab.

50811 (IWGFR–65, pp. 233-245) **Static and dynamic buckling of thin hemispherical and cylindrical shells fluid-coupled with a rigid vessel: Tests and calculations.** De Paulis, A. (Pisa Univ. (Italy). Dipt. di Costruzioni Meccaniche e Nucleari); Guiggiani, M.; Garuti, G.; Vigni, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

In the last years the development of pool type LMFBRs has led to consider both the dynamic behaviour and the stability of thin shells interacting with a fluid which surrounds them. These problems are relevant when structures made of thin shells are subjected to violent motion as in the case of earthquake. This paper reports some experimental and numerical results on the dynamic stability of thin shells fluid coupled with a concentric rigid vessel. The gap between the shell and the vessel is filled with liquid and the loads on the thin shell are essentially pressures associated with the dynamic excitation. 10 refs, 15 figs.

50812 (IWGFR–65, pp. 246-257) **The benefits and problems of base seismic isolation for LMFBR reactor plants.** Seidensticker, R.W. (Argonne National Lab., IL (USA). Reactor Analysis and Safety Div.). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The use of seismic isolation as an approach to aseismic design has gained increasing interest as a viable and efficient engineering solution to earthquake ground motion both within and outside of the nuclear field. Seismic isolation design is fundamentally different from conventional design practice. In the conventional approach, seismic loads are resisted by making the structures, equipment, piping, and associated supports strong enough to resist seismic loads and to provide high levels of ductility. The use of seismic isolation approaches the problem by decoupling the structure (and its contents) from the seismic input resulting from ground shaking. Because LMFBR systems operate at virtually atmospheric pressure, vessels, piping, and associated components tend to be quite thin-walled. The problem is that these thin-walled items have little inherent resistance to earthquake effects and are vulnerable to seismic load effects. As a result, earthquake loads have an even greater influence on LMR designs than they already are in LWR

plants. The potential benefits of seismic isolation for an LMR plant are considerable, including minimization of high-cost commodities such as stainless steel, large reductions in internal equipment loads, increased margins of safety for beyond-design-basis loads, and enhancement of plant standardization design. There are, of course, a number of issues and concerns in the use of seismic isolation for a nuclear power plant. These issues cover a number of items such as the lack of experience in actual earthquakes, effects of long-period ground motion, effect of vertical loads, traveling waves, and other related concerns. This paper presents an evaluation of the benefits and problems in the use of seismic isolation in LMR plants. 12 refs, 7 figs.

50813 (IWGFR–65, pp. 257-268) **Approach to LMFBR floor response reduction.** Sawada, Yoshihiro (Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan)); Sakurai, Akio; Kurihara, Chizuko. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

To reduce seismic load for the nuclear components of pool-type LMFBR, dynamic characteristics of the partially embedded reactor building, optimum depth of embedment and adequacy of response analysis method were examined. In addition to this, introduction of several isolation systems, siting on the soft rock and inshore floating plant were also investigated to evaluate possibility of further rationalization of seismic design. (author). 15 figs, 1 tab.

50814 (IWGFR–65, pp. 268-277) **U.K. base seismic isolation systems, design studies and R and D programme.** Austin, N. (National Nuclear Corp. Ltd., Risley (UK)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper summarises the principal activities in the United Kingdom on seismic isolation. Progress has been made towards answering some of the potential technical and licensing questions and future research programmes have been initiated to investigate the outstanding issues. (author). 12 refs, 7 figs.

50815 (IWGFR–65, pp. 280-291) **Seismic behaviour of a fast reactor core.** Bernard, A.; Brochard, D.; Gantenbein, F. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper presents the project calculations performed for the seismic verification of the core of the reactor SPX1. This presentation includes the seismic characteristics of the core and the subassemblies, the core seismic response calculations and the consequences of the core seismic behaviour within the framework of the project studies. Then a detailed description of the validation tests performed on the shacking table with the scale 1/3 rd core mock-up Rapsodie is given. (author). 15 figs.

50816 (IWGFR–65, pp. 292-309) **Numerical and experimental studies carried out in the framework of PEC core seismic analysis.** Martelli, A. (ENEA, Bologna (Italy). Dipt. Reattori Veloci); Forni, M.; Bonacina, G.; Melloni, R. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Sophisticated numerical techniques had to be developed and a wide-ranging experimental programme had to be performed to allow the PEC core seismic response to be correctly analysed. The numerical techniques mainly consisted of the 1D computer program CORALIE, jointly developed by ENEA and CEA for the non-linear core analysis, and an iterative procedure for the reactor-block calculations (taking into account vessel-core mechanical coupling). This procedure, that is described in a separate paper, makes use of linearized models, that are defined on the basis of the results of the CORALIE calculations. A long series of experiments was performed on simplified mock-ups and prototypes of all the various element types that are present in the core, for both the original and the final, modified, design solutions. Tests were performed in air and water (simulating sodium), with excitations increasing up to above SSE. Single prototype elements, couples and a group of three fuel elements were tested. Groups of seven and nineteen simplified elements reproducing actual core parts were analysed. Experiments with simulation of the PEC core-restraint ring and direct measurements of shock forces were carried out. All the tests were analysed by means of CORALIE. The tests performed on 7- and 19-element groups were also analysed using the 2D computer program CLASH, developed by Belgonucleaire. The paper summarizes the fundamentals of the numerical and experimental studies. It also contains in the Appendix some notes on the analysis performed for the Intermediate PEC Safety Report and the use of the results of such analysis for structural and functional verifications. (author). 26 refs, 13 figs, 2 tabs.

50817 (IWGFR–65, pp. 309-312) **Core seismic analysis SNR-2 preliminary design and R and D program.** Preumont, A. (Societe Belge pour l'Industrie Nucleaire, Brussels (Belgium)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper reviews the work done at Belgonucleaire in the framework of the seismic analysis of FBR cores and subassemblies. The main features of the computer programme CLASH are first reviewed. Next, the main conclusions of the preliminary analysis of SNR-2 are examined. Finally, the objectives of future research are outlined and the status of the R and D program at Belgonucleaire is given. (author). 8 refs.

50818 (IWGFR–65, pp. 312-324) **Seismic analysis methods for LMFBR core and verification with mock-up vibration tests.** Sasaki, Y. (Toshiba Corp., Kawasaki, Kanagawa (Japan). Research and Development Center); Kobayashi, T.; Fujimoto, S.; Morishita, M.; Iwata, K.; Imazu, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper deals with the vibration behaviors of a cluster of core elements with the hexagonal cross section in a barrel under the dynamic excitation due to seismic events. When a strong earthquake excitation is applied to the core support, the cluster of core elements displace to a geometrical limit determined by restraint rings in the barrel, and collisions could occur between adjacent elements as a result of their relative motion. For these reasons, seismic analysis on LMFBR core elements is a complicated

non-linear vibration problem, which includes collisions and fluid interactions. In an actual core design, it is hard to include hundreds of elements in the numerical calculations. In order to study the seismic behaviors of core elements, experiments with single row 29 elements (17 core fuel assemblies, 4 radial blanket assemblies, and 8 neutron shield assemblies) simulated all elements in MONJU core central row, and experiments with 7 cluster rows of 37 core fuel assemblies in the core center were performed in a fluid filled tank, using a large-sized shaking table. Moreover, the numerical analyses of these experiments were performed for the validation of simplified and detailed analytical methods. 4 refs, 18 figs.

50819 (IWGFR–65, pp. 325-331) **The seismic assessment of fast reactor cores in the UK.** Duthie, J.C. (UKAEA Northern Research Labs., Springfields (UK)); Dostal, M. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The design of the UK Commercial Demonstration Fast Reactor (CDFR) has evolved over a number of years. The design has to meet two seismic requirements: (i) the reactor must cause no hazard to the public during or after the Safe Shutdown Earthquake (SSE); (ii) there must be no sudden reduction in safety for an earthquake exceeding the SSE. The core is a complicated component in the whole reactor. It is usually represented in a very simplified manner in the seismic assessment of the whole reactor station. From this calculation, a time history or response spectrum can be generated for the diagrid, which supports the core, and for the above core structure, which supports the main absorber rods. These data may then be used to perform a detailed assessment of the reactor core. A new simplified model of the core response may then be made and used in a further calculation of the whole reactor. The calculation of the core response only, is considered in the remainder of this paper. One important feature of the fast reactor core, compared with other reactors, is that the components are relatively thin and flexible to promote neutron economy and heat transfer. A further important feature is that there are very small gaps between the wrapper tubes. This leads to very strong fluid-coupling effects. These effects are likely to be beneficial, but adequate techniques to calculate them are only just being developed. 9 refs, figs.

50820 (IWGFR–65, pp. 332-338) **Fluid structure interaction in LMFBR cores modelling by an homogenization method.** Brochard, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The upper plenum of the internals of PWR, the steam generator bundle, the nuclear reactor core, may be schematically represented by a beam bundle immersed in a fluid. The dynamical study of such a system needs to take into account fluid structure interaction. A refined model at the scale of the tubes can be used but leads to a very difficult problem to solve even on the largest computers. The homogenization method allows to have an approximation of the fluid structure interaction for the global behaviour of the bundle. It consists of replacing the heterogeneous physical medium (tubes and fluid) by an equivalent homogeneous medium whose characteristics are determined from the resolution of a set of problems on the elementary cell. The aim of this paper is to present the main steps of the determination of this equivalent medium in the case of small displacements (acoustic behaviour of the fluid). Then an application to LMFBR core geometry has been realised, which shows the lowering effect on eigenfrequencies due to the fluid. Some comparisons with test results will be presented. 6 refs, 7 figs, 2 tabs.

50821 (IWGFR–65, pp. 340-379) **Analysis of the dynamic behaviour of the PEC shutdown system. Pt. 1. Experimental tests; Pt. 2. Validation of the numerical analysis.** Bonacina, G. (ISMES S.p.A., Bergamo (Italy)); Franchioni, G.; Zola, M.; Maresca, G.; Martelli, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This technical report deals with the experimental research carried out in 1984-1985 by the Dynamic Tests Department of ISMES, Bergamo, Italy, on a mock-up of the Drive Mechanism - Control Rod System (Shutdown Mechanism) of the PEC Sodium Cooled Fast Reactor. The research was sponsored by Ansaldo Divisione NIRA, Genova, Italy, with the cooperation of ENEA, Bologna, Italy, in the frame of the experimental activities in support of the PEC seismic verification. The first part of the report illustrates some aspects particularly related to the experimental details of the research, such as: criteria for the simulation of the actual environment, design of the test rig, tests design, instrumentation and equipment, criteria for test data processing and so on. The second part deals with some aspects of the seismic tests carried out by ISMES on a full scale mock-up of the Drive Mechanism and Control Rod (Shutdown System) of the PEC fast reactor, and the calculations performed by NIRA in order to reproduce the results of these tests, showing the possibility to use the model pointed out, with only a few modifications, to determine the stress level of the mechanism and the scramability of the rod in the reactor. Some comparisons between experimental and numerical results are shown, and the scramability of the rod is demonstrated for different seismic motions. 15 refs, 52 figs.

50822 (IWGFR–65, pp. 380-386) **Seismic qualification of SPX1 shutdown systems - tests and calculations.** Brochard, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Buland, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The SUPERPHENIX 1 shutdown system is composed of two main systems: the Complementary Shutdown System SAC (Systeme d'Arret Complementaire) and the Primary Shutdown System (SCP) (Systeme de Commande Principal). In case of a seismic event, the insertability of the different shutdown systems has to be demonstrated. Tests have been performed on the SAC and have shown that this system was not sensitive to the seismic excitation (the drop time increases of 10% at SSE level). For the SCP, as an analytical demonstration was felt difficult to achieve, it was decided to perform a full scale testing program. These tests have been performed for the two types of SCP which are present in Superphenix: SCP 1 (Creusot Loire design), SCP 2 (Novatome design). As there was no existing facility in France to test this kind of slender structure (21 metres high) a new facility named VESUBIE was designed and installed in an existing pit located at the Saclay nuclear research center. The objectives of the tests were the following: to demonstrate insertability of control rod; to demonstrate absence of seismic induced damage to the SCP; to measure increase of scram time; to measure seismic induced stresses; to obtain data for code correlation. After completion of the tests, measurements have been correlated with results obtained from a non-linear finite element model. Time history correlations were achieved for SCP 1. Afterwards a calculation was performed in hot condition to find if

there was some effect of temperature on SCP seismic response. 2 refs, 8 figs.

50823 (IWGFR–65, pp. 387-399) **Functional integrity evaluation on "MONJU" control rod drive mechanism under earthquake conditions.** Tanimoto, K. (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Shipbuilding and Engine Works); Shimomura, T.; Fujita, K.; Ohya, T.; Amada, K.; Okabayashi, K. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper presents the study on the functional integrity of FBR "MONJU" Control Rod Drive Mechanism (CRDM) under earthquake. CRDM of "MONJU" is required to maintain the function to insert control rods into the core in 1.2 sec. to 85% of the full stroke which is conservatively determined from the viewpoint of the core safety. Therefore, to evaluate these functions, the scram tests were carried out by using the sinusoidal and artificially simulated earthquake waves. These waves had the amplitude and acceleration equivalent to or larger than those of S_2 earthquake defined in "MONJU" plant design. From the results of these tests, CRDM had excellent performance in inserting control rods into the core within the allowable time under all of the test conditions and, it was clarified that CRDM was well designed against the earthquake. (author). 14 figs, 3 tabs.

50824 (IWGFR–65, pp. 399-403) **Seismic performance capabilities of the alternative shutdown system proposed for C.D.F.R.** Wootton, M. (National Nuclear Corp. Ltd., Risley (UK)); Dostal, M. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper discusses the seismic performance capabilities of the alternative shutdown system together with seismic vibration tests that were carried out on a full scale water test rig modelling the system. Experimental results showed that no degradation in system performance occurred under simulated lateral seismic excitation up to the maximum levels achievable on the test rig. (author). 2 refs, 6 figs.

50825 (IWGFR–65, pp. 404-412) **Neutronic and thermal behaviour of the PEC core in an earthquake.** Cecchini, F. (ENEA, Bologna (Italy). Dipt. Reattori Veloci); Artioli, C.; Di Francesca, R.; Montanelli, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

During a seismic event, the PEC core moves in a complicated way in the horizontal plane and the fuel volume changes with positive and negative vibrations; these variations cause reactivity insertions. For evaluating the maximum reactivity insertions, corresponding to the two design earthquakes (1/2TSS = OBE and TSS = SSE) a methodology, based on static compactions, was applied to the core; the time functions of reactivity variation were derived from the detailed core seismic analysis performed with CORALIE and were subsequently normalized (for TSS) to the static maximum reactivity values. Finally, the core thermodynamic response was computed for verifying that the effects were permissible from a safety point of view, even in an uncontrolled event hypothesis. (author). 6 figs, 1 tab.

50826 (IWGFR–65, pp. 413-425) **Criteria for structural verification of fast reactor core elements.** Cecchini, P. (ENEA, Bologna (Italy). Dipt. Reattori Veloci); Neri, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Structural and functional criteria and relative verifications of PEC reactor fuel element are presented and discussed. Particular attention has been given to differentiate the structural verifications of low neutronic damage zones from those high neutronic damage ones. The structural verification criteria, which had already been presented at the 8th SMIRT Seminar Conference in Paris, have had some modifications during the Safety Report preparation. Finally some necessary activities are indicated for structural criteria validation, in particular for irradiated components, and for converging towards a European fast reactor code. (author). 3 refs, 6 tabs.

50827 (IWGFR–65, pp. 428-439) **Vibrational characteristics of fluid filled gap support systems.** Sasaki, Y. (Toshiba Corp., Kawasaki, Kanagawa (Japan). Research and Development Center); Kondo, H.; Yamamoto, S.; Hirayama, H.; Sukurai, A.; Sawada, Y.; Masuko, Y. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

A fluid filled gap support system is a hydrodynamic support system, which is composed of an inner cylinder and an outer restraint cylinder surrounding the inner cylinder, with a small gap between them filled with fluid. In pool type LMFBRs, the fluid filled gap support system is considered to be efficient as a seismic support system for internal components, such as pumps, IHXs etc., which are suspended from the deck. Because this support system has no mechanical connections with internal components, and accommodates the thermal deformation without causing thermal stress. This support system fundamentally has a two concentric cylindrical geometry separated by an annular fluid region. Previously, two dimensional analyses on this cylindrical structure were performed, neglecting axial flows in the annular region, by Fritz and Chen. It has been proved analytically and experimentally that the fluid filled gap support system was effective to restrain component vibration, and that axial flows in the annular gap reduced supporting effects. So, it is expected that the system will be improved in performance by suppressing axial flows in the annular gap. In this study, a device using seal rings was designed to suppress the axial flow described above. Analyses were performed to evaluate vibrational characteristics for the system, such as added mass and damping factors. Also, vibration tests with the seal rings were performed to examine the validity of the analytical method, and vibration test without the seal rings were performed in a large response amplitude to examine the vibration characteristics. Finally, a design calculation for a core support cylinder was performed for the evaluation of support systems. 5 refs, 12 figs, 2 tabs.

50828 (IWGFR–65, pp. 439-459) **Dynamic analysis of the PEC fast reactor vessel: On-site tests and mathematical models.** Zola, M. (ISMES S.p.A., Bergamo (Italy)); Martelli, A.; Maresca, G.; Masoni, P.; Scandola, G.; Descleve, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic*

design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987. 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper presents the main features and results of the on-site dynamic tests and the related numerical analyses carried out for the PEC reactor vessel. The purpose is to provide an example of on-site testing of large components, stressing the problems encountered during the experiments, as well as in the processing phase of the test results and for the comparisons between calculations and measurements. Tests, performed by ISMES on behalf of ENEA, allowed the dynamic response of the empty vessel to be measured, thus providing data for the verification of the numerical models of the vessel supporting structure adopted in the PEC reactor-block seismic analysis. An axisymmetric model of the vessel, implemented in the NOVAX code, had been developed in the framework of the detailed numerical studies performed by NOVATOME (again on behalf of ENEA), to check the beam schematization with fluid added mass model adopted by ANSALDO in SAP-IV and ANSYS for the reactor-block design calculations. Furthermore, a numerical model, describing vessel supporting structure in detail, was also developed by ANSALDO and implemented in the SAP-IV code. The test conditions were analysed by use of these and the design models. Comparisons between calculations and measurements showed particularly good agreement with regard to first natural frequency of the vessel and rocking stiffness of the vessel supporting structure, i.e. those parameters on which vessel seismic amplification mainly depends: this demonstrated the adequacy of the design analysis to correctly calculate the seismic motion at the PEC core diagrid. (author). 5 refs, 23 figs, 4 tabs.

50829 (IWGFR–65, pp. 460-492) **Seismic tests in sodium of the SPX-1 primary pump shaft carried out in the CPV-1 test rig at ENEA-Brasimone.** Contardi, T. (ENEA/VEL Brasimone (Italy)); Rapezzi, L.; Le Coz, P.; Tigeot, Y.; Partiti, C.; Zola, M.; Denimal, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Dynamic tests were carried out by ISMES, on behalf of ENEA and CEA and in co-operation with FIAT/TTG, on a SPX-1 primary pump shaft. These tests were conducted, mainly in sodium, in the CPV-1 test rig at the ENEA Brasimone Center. The excitation was applied to the flange supporting the hydrostatic bearing. After some preliminary analysis performed in absence of liquid sodium and at ambient temperature, the following tests were performed on the rig filled with sodium at operating temperature: (A) sine sweeps between 1 and 15 Hz, (B) ambient vibration investigation, and (C) seismic tests with a SSE acceleration time-history (20 s duration) calculated by CEA at hydrostatic bearing level. Two sets of seismic tests were carried out, each time increasing amplitudes up to 70% of SSE. This value was not exceeded for safety reasons and actuator power limit. The first set of tests began in nominal operating conditions; when 70% of SSE was reached, pressure feed to hydrostatic bearing was reduced lowering its effective support. This simulated a larger earthquake. The second set of tests was representative of SPX-1 pump actual operating conditions, because both hydrostatic bearing pressure and shaft rotating speed were simultaneously reduced following the primary pump characteristic curve. The tests allowed the SPX-1 pump rotating set to be widely qualified. Among the main results, it is worth noting that the stiffness of the hydrostatic bearing system was generally compatible with seismic requirements. Finally, it is worth pointing out that, in order to allow the above-mentioned tests to be carried out, a full seismic qualification of the CPV-1 test rig was necessary: thus, this rig might be used in the future for further seismic tests on LMFBR components and systems in sodium. (author). Figs and tabs.

50830 (IWGFR–65, pp. 493-500) **Seismic stability analysis of BN-800 reactor plant.** Vilensky, O.J.; Zhukov, V.V.; Kaidalov, V.B.; Silajev, V.M.; Tatarsky, J.N. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Calculation results of fast neutron reactor plant BN-800 seismic stability are presented. Data on calculation method verification on large-scale model are also given. (author). 6 figs, 2 tabs.

50831 (IWGFR–65, pp. 500-504) **Accounting the seismic effect in NPP pipeline analysis.** Matsepura, R.P.; Figurina, I.G.; Chikunova, T.N. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

This paper describes the seismic design criteria and procedures used for the design of BN-800 power station. It is pointed out that the BN-800 primary piping was designed to be very flexible (2.5 Hz frequency) due to thermal expansion, but the seismic loads did not require ad-hoc seismic supporting devices, because of low seismic intensity levels. The seismic evaluations made in the design stage were based on static methods using Floor Response Spectra acceleration values at the first piping natural frequency. The results will be checked according to new standards, that require a full dynamic analysis. 4 refs, 2 tabs.

50832 (IWGFR–65, pp. 504-509) **Seismic qualification of piping systems based on strain criteria.** Peters, K. (Internationale Atomreaktorbau GmbH (INTERATOM), Bergisch Gladbach (Germany, F.R.)); Rangette, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Typical LMFBR piping is characterized by elevated temperature and low pressure levels. Taking into account operational conditions only these characteristics demand for and allow flexible piping design. The overestimation of the damage potential of seismic loading by e.g. improper failure criteria usually contradicts operational needs producing the known result of excessive "snubberism" and reduction of operational margins. As a matter of fact, due to its transiency seismic loading is essentially secondary provoking the natural design requirement ductility instead of stiffness and rigidity - i.e. exclusion of failure by strain control instead of stress control - and thus avoiding the LMFBR typical competition between operational needs and seismic qualification. The design requirement ductility needs judgement mechanisms, i.e. suitable load descriptions, allowed strain levels and strain evaluation tools. A simplified method for strain range estimation and the underlying basic ideas are roughly outlined. The status of verification and experience gained so far is described. The results achieved suggest that the qualification of piping based on ductility requirement controlled by strain criteria is not out of reach. (author).

50833 (IWGFR–65, pp. 509-525) **Seismic analysis method of MONJU liquid metal pipings and verification with seismic tests on model pipings.** Ohya, T. (Power Reactor and Nuclear Fuel Development Corp. (Japan)); Inoue, T.; Yamagishi, A.; Kobayashi, T.; Mizuno, S.; Kawara, M. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct

1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The heat transport system pipings of the prototype LMFBR "MONJU" are thin walled pipings with large diameter and are supported by pipeclamps and mechanical snubbers, therefore the piping system may have nonlinear dynamic characteristics during a seismic event due to gaps in the support structures and local deformation of the thin walled piping. For this reason it is necessary to develop an equivalent linear modelling method for these structures in order to apply the response spectrum method which is generally adopted as the seismic analysis method at present to these systems. Vibration tests were performed using full scale models for pipe supporting structures of the primary heat transport system piping and a 1/4 scale model piping system for the hot leg piping system of the prototype LMFBR "MONJU". The purpose of these tests was to investigate the effect of nonlinear characteristics of a pipe supporting structure with gaps on pipe vibration behavior experimentally and analytically. As a result of these tests and analyses, it was clarified that the nonlinear characteristics of a pipe supporting structure with gaps could be represented by the equivalent linear support stiffness. Therefore the equivalent linear modelling method could be applied to the primary heat transport system piping of the prototype LMFBR "MONJU" as the design analysis for licensing. (author). 28 figs, 4 tabs.

50834 (IWGFR–65, pp. 525-535) **Piping seismic fragility tests.** Jetter, R.I. (Energy Technology Engineering Center, Canoga Park, CA (USA)); Chen, W.P.; Onesto, A.T.; DeVita, V. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; ENEA, Bologna (Italy). Dipt. Reattori Veloci. Feb 1988. (CONF-8710379–: Specialists' meeting on fast breeder reactor-block antiseismic design and verification, Bologna (Italy), 12-15 Oct 1987). In *Fast breeder reactor-block antiseismic design and verification: Proceedings of the specialists' meeting held in Bologna, Italy, 12-15 October 1987.* 535p. Order Number DE91604686. Source: NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

Three piping systems have been recently tested to failure at the Energy Technology Engineering Center (ETEC) seismic test facility. These tests were sponsored by the U.S. Nuclear Regulatory Commission (NRC) in response to a recommendation from the Seismic Design Task Group of the U.S. NRC Piping Review Committee and by the U.S. Department of Energy (DOE). The objective of the tests was to investigate the ability of representative nuclear piping systems to withstand high level dynamic seismic and other loadings. The levels of loadings achieved during seismic testing were more than an order of magnitude greater than usually specified for Safe Shutdown Earthquake (SSE's) of contemporary nuclear power plants. Based on the failure data obtained, it was concluded that nuclear piping systems are able to withstand much larger seismic loads than currently permitted by design criteria in existing codes and standards. The piping systems were representative of Light Water Reactor (LWR) designs, three to six inches in diameter, and two of them were pressurized. The piping system failures were localized ruptures attributable to ratchetting and fatigue. The systems did not collapse and did not lose functionality prior to failure. The purpose of this paper is to describe the test facility, test articles and test results and to comment on potential application to, and testing of, Liquid Metal Reactor (LMR) piping. (author). 2 refs, 9 figs, 1 tab.

50835 Nuclear reactor with internal thimble-type delayed neutron detection system. Gross, K.C.; Poloncsik, J.; Lambert, J.D.B. To Dept. of Energy, Washington, DC (USA). USA Patent 4,938,917/A/. 3 Jul 1990. Filed date 17 Nov 1988. USA Patent patents application 7-272,583. Int. Cl. G21C 17/06. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This paper describes a liquid-metal cooled nuclear reactor. It comprises: a housing having a core containing nuclear material, a shell and tube heat exchanger positioned within the housing. The shell and tube heat exchanger have the tubes thereof arranged in parallel, a primary coolant within the shell and tube heat exchanger, means for detecting positioned within a tube in the shell and tube heat exchanger for generating a signal in response to a reaction detected by the means for detecting, the means for detecting including signal detectors D-1, D-2, and D-3 selectively spaced from one another along the coolant flow within the shell and tube heat exchanger so that the total time lapsed after the occurrence of the reaction and a delayed-neutron is detected is: TOTAL = $T_h + T_t + T_d$. Where: T_h = isotopic holdup time for the delayed-neutron traveling from the reaction spot to the coolant T_t = transit time for the delayed-neutron traveling from the coolant to the heat exchanger inlet T_d = constant transit time for the delayed-neutrons to reach each of the delayed-neutron detectors D-1, D-2, and D-3, which is dependent upon the position of the delayed-neutron detector; and a mechanism remotely connected to the signal detectors to record the reaction detected thereby.

50836 Sidewall containment of liquid metal with horizontal alternating magnetic fields. Pareg, W.F. To Dept. of Energy, Washington, D.C. (USA). USA Patent 4,936,374/A/. 26 Jun 1990. Filed date 17 Nov 1988. USA Patent patents application 7-272,353. Int. Cl. B22D 27/02. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes an apparatus for confining molten metal. It comprises: containment means having an open side; a magnet capable of generating a mainly horizontal alternating magnetic field. The the magnet is located adjacent to the open side of the containment means whereby the field generated by the magnet is capable of inducing eddy currents in a thin layer at the surface of the molten metal which interact with the magnetic field producing a force that can contain the molten metal within the containment means; wherein the magnet includes: magnetic poles located adjacent to the open side of the confinement means; a core connecting the poles; a coil encircling the core, the coil capable of being responsive to a current source; whereby an alternating magnetic field can be generated between the poles and parallel to the open side of the containment means so that a molten metal can be confined within the confinement means.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 50848

2107 Regulation and Licensing

50837 (HSE-Trans–13402B) **Directive concerning the requirements on qualification as well as training and further training of nuclear power station personnel to ensure nuclear safety and radiation protection.** Health and Safety Executive, London (UK). Sep 1989. 13p. Translated from Mitteilungen des Staatlichen Amtes fuer Atomsicherheit und Strahlenschutz, (1986) v. 23(7) p. 1-12. Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Mitteilungen des Staatlichen Amtes fuer Atomsicherheit und Strahlenschutz, (1986) v. 23(7) p. 1-12.

This directive lays down the requirements on the qualification as well as the training and further training of persons directly concerned with ensuring nuclear safety and radiation protection in the commissioning, operation or maintenance of nuclear power stations. It applies to the integrated plants, plants and institutes which commission, operate or maintain nuclear power stations. (author).

50838 (NUREG–0750-Vol.31-Index-2) **Indexes to Nuclear Regulatory Commission Issuances, January–June 1990: Volume 31, Index 2.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. 1990. 76p. Sponsored by Nuclear Regulatory Commission. Source: NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Digests and indexes for issuances of the Commission (CLI), the Atomic Safety and Licensing Appeal Panel (ALAB), the Atomic Safety and Licensing Board Panel (LBP), the Administrative Law Judge (ALI), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking are presented in this document. These digests and indexes are intended to serve as a guide to the issuances. These information elements are displayed in one or more of five

separate formats arranged as follows: case name index, digests and headers, legal citations index, subject index, and facility index.

2108 Economics

Refer also to citation(s) 50940

50839 (HSE-Trans–13399G) **The nuclear industry within the Community: Nuclear power: design and construction industry within the single European market.** Health and Safety Executive, London (UK). Nov 1989. 36p. Translation of CES Report Draft. Revision 2. JCC/f.v. (31 May 1989). Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ 31 p. (Updating the Community Provisional Nuclear Programme, PINC, in accordance with article 40 of the Euratom Treaty, adopted by the Commission in 1984 and published in 1985, together with the CES report).

Translation of CES Report Draft. Revision 2. JCC/f.v. (31 May 1989).

As part of its 1989 working programme, the European Commission undertook to update the provisional nuclear programme in the view of the expected changes from the single European market. This document complies with that commitment and deals exclusively with the problems of the industry engaged in the design and construction of electro-nuclear power stations. Having analysed the context and prospects for the medium and long term development of nuclear investments, in particular in relation to the establishment of a "common electricity market", the practical possibility of opening up the equipment and services market is examined. Actions to be taken within the Community are indicated. Finally, the standard for power stations equipped with fast neutron breeder reactors, where European efforts are directed towards a single development project, is presented. (UK).

22 NUCLEAR REACTOR TECHNOLOGY

Refer also to citation(s) 52561

2201 Theory and Calculation

Refer also to citation(s) 51416, 52227

2202 Components and Accessories

Refer also to citation(s) 50882, 50888, 51388

50840 (FEI–1965) **Numerical method for calculating deformed-stressed state of NPP cylindrical elements under axisymmetric loads.** Leonchuk, M.P.; Pyl'chenkov, Eh.Kh.; Sharadina, L.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst. 1989. 20p. (In Russian). Order Number DE91604585. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Methods and algorithm for computerized numerical solution of the problem of deformed-stressed state of cylindrical elements under two-dimensional (r,z) axisymmetric loading are presented. A system of finite-difference equations, approximating initial relations is solved by the longitudinal-lateral run method. The method includes calculation of plastic deformations and creep. Comparison with the known solutions obtained by other methods manifests the considered method and program serviceability and its applicability when calculating strength of NPP elements. 11 refs.; 5 figs.

50841 (HSE-Trans–13314B) **The USSR State Committee for Supervising Work Safety in the Nuclear Power Industry: information and remarks.** Health and Safety Executive, London (UK). Jul 1989. 11p. Translated from Prilozheniye k informatsionnomu byulletenyu (May 1989) no. 2. Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Prilozheniye k informatsionnomu byulletenyu (May 1989) no. 2.

The structure of the USSR State Committee for Supervising Work Safety in the Nuclear Power Industry (USSR Gosatomenergonadzor) is outlined. Brief reports are given on recent activities. These include: a summary of unplanned shutdowns and infringements of safety regulations at nuclear power stations in May 1989; a visit to the USSR by a delegation from Britain's Nuclear Installations Inspectorate; examination of the feasibility study for the expansion of the Novovoronezhskaya nuclear power station; a meeting on openness (glasnost) in the nuclear power industry; an investigation of the construction of the Gor'kiy nuclear power station for supplying heat; a review of progress of work on full-scale simulators; the design of the third phase of the Beloyaskaya nuclear power station; checking the safety and readiness of unit 5 to be put into commission at the Zaporozh'ye nuclear power station. (UK).

50842 (JAERI-M–90-089) **The present state of art on EAC of RPV/LWR and their relevance to R and D in flaw evaluation.** Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 75p. (In Japanese). Order Number DE91713051. Source: NTIS (US Sales Only), PC A04/MF A01.

The assessment of environmentally assisted cracking (EAC) of structural materials of LWR has been carried out extensively within a decade as one of the critical issues in evaluating the structural integrity of the pressure boundary components of the reactor primary circuit. In this report, the present status on EAC of the reactor pressure vessel (RPV) steel is reviewed. The research themes being required for application to the flaw evaluation of the RPV are also discussed, and a direction of the future activity of the JCF group is suggested. As to the crack growth characteristics, lack in systematic data sets, e.g. crack growth near threshold region in the environment, is pointed out, and further parametric studies especially focused on the effects of environmental variables are recommended. The further understanding of the mechanism and the modeling on EAC, e.g. typically the time domain analysis, are also stressed, which results in an improvement of the quantitative flaw evaluation and residual life estimation of RPV. (author).

2203 Fuel Elements

Refer also to citation(s) 50875

50843 (IAE–4841-3) **Critical heat transfer under selforganizing vortex structures in the coolant flow.** Kiknadze, G.I.; Kryuchkov, I.I.; Chushkin, Yu.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 29p. (In Russian). Order Number DE91604598. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results obtained in investigating the effect of the vortex intensification of heat exchange on the critical heat fluxes in the energy-exchange channels with a streamline surface formed by the regular pattern of spherical pits are reported. The investigations were carried out in the bundles of heated rods and in annular channels at a mass flow rate of 1000 to 5000 kg/(cm^2.s), a coolant pressure of 1.0 to 0.6 MPa and 10 to 17.5 MPa, a relative enthalpy of flux of 0.4 to -0.5. 14 refs.; 12 figs.

50844 (NIIAR–15(746)) **Technique for mass-spectrometric determination of moisture content in fuel elements and fuel element claddings.** Kurillovich, A.N. (and others); Pimonov, Yu.I.; Biryukov, A.S. Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR). 1988. 10p. (In Russian). Order Number DE91604599. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A technique for mass-spectroimetric determination of moisture content in fuel elements and fuek claddings in the $2x10^{-4}$-$1.5x10^{-2}$g range is developed. The relative standard deviation is 0.13. A character of moisture extraction from oxide uranium fuels in the 20-700 deg C temperature range is studied. Approximately 80% of moisture is extracted from the fuels at 300 deg C. The moisture content in fuel elements with granular uranium oxide fuels is measured. Dependence of fuel element moisture content on conditions of hot vacuum drying is shown. The technique permits to optimize the fuel element fabrication process to decrease the moisture content in them. 4 refs.; 3 figs.; 2 tabs.

50845 (NIIAR–25(756)) **Research problems of fission product behaviour in fuels of nuclear power plants and ways of their solution.** Sulaberidze, V.Sh. Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR). 1988. 20p. (In Russian). Order Number DE91604600. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The most important problems of studying behaviour of fission products in fuel elements of maneouvrable nuclear power plants units are formulated. In-pile and out-of-pile investigation methods solving these problems are characterized in brief. 12 refs.; 2 figs.

50846 **System for fuel rod removal from a reactor module.** Matchett, R.L.; Roof, O.R.; Kikta, T.J.; Wilczynski, R.; Nilsen, R.J.; Bacvinskas, W.S.; Fodor, G. To U.S. Dept. of Energy, Washington, DC (USA). USA Patent 4,903,281/A/. 20 Feb 1990. Filed date 28 Jul 1988. USA Patent patents application 7-225,435. Int. Cl. G21C 19/00. 6p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a robotic system for remote underwater withdrawal of the fuel rods from fuel modules of a light water breeder reactor includes a collet/grapple assembly for gripping and removing fuel rods in each module, which is positioned by use of a winch and a radial support means attached to a vertical support tube which is mounted over the fuel module. A programmable logic controller in conjunction with a microcomputer, provides control for the accurate positioning and pulling force of the rod grapple assembly. Closed circuit television cameras are provided which aid in operator interface with the robotic system.

2204 Control Systems

50847 (CONF-9002100–, pp. 163-170) **Status of the University of Missouri-Columbia research reactor upgrade.** McKibben, J.C. (Univ. of Missouri Research Reactor, Columbia (USA)); Edwards, C.B. Jr.; Meyer, W.A. Jr.; Kim, Soon Sam. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The University of Missouri-Columbia (MU) Research Reactor facility staff is in the process of upgrading the operational and research capabilities of the reactor and associated facilities. The upgrades include an extended life aluminide fuel element, a power increase, improved instrumentation and control equipment, a cold neutron source, a building addition, and improved research instrumentation and equipment. These upgrades will greatly enhance the capabilities of the facility and the research programs. This paper discusses the parts of the upgrade and current status of implementation.

50848 (IWGFR–69, pp. 163-191) **A survey of control rod measurements in ZPPR and their analysis.** Collins, P.J. (Argonne National Lab., Idaho Falls, ID (USA)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. May 1990. DOE Contract W-31-109-ENG-38. (CONF-881252–: IAEA specialists' meeting, Winfrith (UK), 6-8 Dec 1988). In *Methods for reactor physics calculations for control rods in fast reactors. Proceedings of a specialists meeting.* 441p. Order Number DE90016214. Source: NTIS (US Sales Only), PC A18/MF A01.

A large number of measurements of control rod worths have been made at ZPPR over the past 16 years, covering a wide range of fast reactor core designs. Both experimental techniques and analytical methods have improved over this period. The results of analysis using ENDF/B-IV and ENDF/B-V.2 nuclear data are reviewed and the calculation methods employed are described in some detail. Special experiments of control rod heterogeneity and boron enrichment effects have been made to aid extrapolation from critical experiments to power reactors. The analysis of parameters related to insertion of control rods into the core, such as fission rate distributions, is also summarized.

50849 (IWGFR–69, pp. 439-441) **IAEA [International Atomic Energy Agency] specialists' meeting on methods for reactor physics calculations for control rods in fast reactors.** Collins, P.J. (Argonne National lab., Idaho Falls, ID (USA)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. May 1990. DOE Contract W-31-109-ENG-38. (CONF-881252–: IAEA specialists' meeting, Winfrith (UK), 6-8 Dec 1988). In *Methods for reactor physics calculations for control rods in fast reactors. Proceedings of a specialists meeting.* 441p. Order Number DE90016214. Source: NTIS (US Sales Only), PC A18/MF A01.

The accurate prediction of control rod worths has been of great concern in the US. Optimum control configurations need to balance several often conflicting requirements of control through the operating cycle, while maintaining acceptable power shapes, safety considerations of overriding importance, together with seeking economy by minimizing the number of rods, reducing boron enrichment and lengthening replacements intervals. After control and shutdown requirements have been met, the most important safety concern is the transient overpower condition (TOP) which may be initiated by uncontrolled run-out of a primary rod. Stringent criteria for the primary and secondary systems may be that they are independently capable of shutting down the reactor even with one rod stuck. The TOP initiator may be greatly enhanced by control rod interaction effects. Control rod effects may have a strong impact on core design. For example, work on the integral fast reactor with metallic fuel at ANL has studied core designs which minimize the TOP reactivity by maintaining a minimum primary control bank insertion through tailoring the internal breeding gain. The predicted control rod worths are very sensitive to the calculation methods used and to the accuracy of the basic nuclear data files. Required accuracies have been achieved only through the use of critical experiments on the ZPR and ZPPR facilities. Experiments on ZPR-3 and ZPR-9 produced satisfactory control predictions for the SEFOR, EBR-II and FFTF reactors.

50850 (PNL-SA–17301) **An approach to acquiring quantitative and qualitative knowledge for fault diagnosis.** Stratton, R.C.; Jarrell, D.B. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900607–1: Advances in human factors research on man-computer interactions: nuclear and beyond, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90017868. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Operation and maintenance activities associated with complex systems require knowledge of the physical system and knowledge of the cognitive task. This paper discusses our methodology for acquiring physical process knowledge necessary for reasoning about faults. Acquisition of process knowledge used in fault diagnosis consists of (1) problem definition and (2) model development. Problem definition activity determines the constraints, physics, physical structure, function, and fault cases associated with the physical system. Model development activity builds knowledge models via fault-case analysis and qualitative analysis. We discuss problem definition and model development activities in context of a single-pass heat exchanger. 6 refs., 4 figs., 3 tabs.

2205 Environmental Aspects

Refer also to citation(s) 51687

50851 (SAND–90-2378C-Draft) **Current status, uses, and limitations of probabilistic accident progression analyses and source term analyses: Draft.** Harper, F.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 17p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (CONF-9009226–3-Draft: Committee on safety of nuclear installations (CSNI), Santa Fe, NM (USA), 4-6 Sep 1990). Order Number DE91000410. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Level 2 PRA analysis can be extremely costly. There are several options that can be used to avoid the high expenditures of time and money to obtain Level 2 insights. With reduced expenditure comes reduced insight into the behavior of specific parameters that contribute to containment failure and large source terms. If the primary objective of a study is quantitative, and does not require insights concerning the complex interactions among physical parameters and system parameters, a reduced scope method can be

acceptable. If primary objectives require the understanding of the relative importance of specific physical processes and the complex interactions among the processes, reduced scope methods should not be used. 19 refs., 1 fig., 4 tabs.

50852 Implementing nuclear energy policy in Japan: top-down and bottom-up perspectives. Lesbirel, S.H. (National Univ. of Singapore (Singapore). Dept. of Japanese Studies). *Energy Policy (UK)*, 18(3): 267-282 (Apr 1990).

Although crucial to Japan, nuclear power has been confronted with increasing siting obstacles. This paper analyses Japan's nuclear policy from the perspective of implementation analysis. It suggests that implementation processes in Japan can and do get delayed more often than many would like to acknowledge because of a reliance on indirect policy instruments by the central government for facilitating bargaining between implementing organizations and target groups. The paper concludes that a site auctioning approach which stresses greater regional input into decision making may assist in the management of siting difficulties. (author).

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 50789, 50792, 50848, 50849, 50874, 52232, 52235

50853 (FEI–1957) **Energy-time density of thermal neutron flux in the IBR-2 reactor moderator.** Stupak, A.I.; Novikov, A.G.; Tarasko, M.Z. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst. 1989. 24p. (In Russian). Order Number DE91604729. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The experiment organization and results of measuring energy-time density of thermal neutron flux in the IBR-2 reactor moderator are described. Characteristics of two time-of-flight diffractometers based on the DIN-2K spectrometric complex are presented. The obtained data testify to weak dependence of neutron pulse shape in moderator on neutron energy. This is due to long width of fast neutron pulse in the IBR-2 reactor (Δt=215mus) and comparatively small range of measured energies (E=5-75 MeV). 19 refs.; 7 figs.; 2 tabs.

50854 (ITEF–66-89) **Lithium converter of reactor neutrons in antineutrino: 1. Static regime of operation.** Lyutostanskij, Yu.S.; Lyashuk, V.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 32p. (In Russian). Order Number DE91604731. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Problems of designing the high-power neutrino source operating in the static mode and having the hard spectrum, when using the lithium convertor of neutrons in antineutrino based on ^{7}Li (n,γ)-activation and formation short-living ($T_{1/2}$=0.84s) radioactive isotope ^{8}Li with hard ν-tilde$_e$-spectrum $E_{max} \approx$ 13 MeV are considered. Efficiency of the convertor in spherical laminated geometry with the heavy-water reflector as a function of purity by ^{7}Li isotope and D_2O layer thickness is calculated. Values of expected tritium activity in the convertor are obtained. The calculations are carried out according to the MAMONT program by the Monte Carlo method. 18 refs.; 10 figs.; 3 tabs.

50855 (LIYF–1435) **WWR-M reactor operating time determination. Part 1.** Alekhin, A.I. (and others); Vasil'ev, G.Ya.; Garusov, E.A. AN SSSR, Leningrad (USSR). Inst. Yadernoj Fiziki. 1988. 22p. (In Russian). Order Number DE91604732. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Flux density and fluences of fast (E>0.8 MeV) and thermal neutrons in the most stressed parts of the WWR-M reactor vessel are determined. Maximum neutron flux density on the bottom of the horizontal channels reaches $(4\pm1)\times10^{12}$ n/cm^{2}xsxMW, thermal neutrons flux density being 10^{13} n/cm^{2}xsxMW. By the 1st of January 1988 maximum fast neutrons fluence for total energy output of 52 GW days made up $(1.2\pm0.2)\times10^{22}$ n/cm^2 on the supporting drig. The predicted maximum fluence in the late 1990 may be 1.4×10^{22} n/cm^2 on the bottom of the channels and 2.2×10^{21} n/cm^2 on the supporting grid. 12 refs.; 3 figs.; 8 tabs.

50856 (ORNL/FTR–3736) **[Reactor dosimetry]: Foreign trip report, August 22, 1990–September 4, 1990.** West, C.D. Oak Ridge National Lab., TN (USA). 13 Sep 1990. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE91000045. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The lead in most aspects of research reactor design and use passed from the USA about 15 years ago, soon after the construction of the HFIR and HFBR. The Europeans have consistently upgraded and improved their existing facilities and have built new ones including the HFR at Grenoble and ORPHEE at Saclay. They studied ultra-high flux concepts ($\sim10^{20}$/m$^{-2}\cdot$s^{-1}) about 10 years ago, and are in the design phase of a new, highly efficient medium flux reactor to be built at Garching, near Munich in Germany. A visit was made to Interatom, the firm – the equivalent of the Architect/Engineer for the ANS project – responsible, under contract to the Technical University of Munich, for the new Munich reactor design. There are many similarities to the ANS design, and we reviewed and discussed technical and safety aspects of the two reactors. A request was made for some new, hitherto proprietary, experimental data on reactor thermal hydraulics and cooling that will be very valuable to the ANS project. I presented a seminar on the ANS project. A visit was made to Kernforschungszentrum Karlsruhe and knowledge was gained from Dr. Kuchle, a true pioneer of ultra-high flux reactor concepts, of their work. Dr. Kuchle kindly reviewed the ANS reference core and cooling system design (with favorable conclusions). I then talked with researchers working on materials irradiation damage and activation of structural materials by neutron irradiation, both key issues for the ANS. I was shown some new techniques they have developed for testing materials irradiation effects at high fluences, in a short time, using accelerated particle beams.

50857 (ORNL/TM–11604) **Oak Ridge Research Reactor shutdown maintenance and surveillance: Semiannual report, October 1989–March 1990.** Coleman, G.H.; Laughlin, D.L. Oak Ridge National Lab., TN (USA). Oct 1990. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE91000699. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Department of Energy ordered the Oak Ridge Research Center Reactor to be placed in permanent shutdown on July 14, 1987. Maintenance activities, both mechanical and instrument, were essentially routine in nature. The performance of the instrumentation for the facility was satisfactory, and maintenance required is provided. The performance of the process system was satisfactory, and maintenance required is indicated. The results of efficiency tests of the various gaseous-waste filters have been summarized and preparations for transfer of the facility to the remedial action program is also indicated.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 50556, 50847

50858 (CONF-9002100–, pp. 1-11) **The project of the new research reactor FRM-II at Munich.** Boening, K. (Technische Universitaet Muenchen, Garching (West Germany)). Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

A new national research reactor is planned in Germany which shall replace the existing FRM reactor at Garching. The new FRM-II will be optimized primarily with respect to beam tube applications but it will also allow the irradiation of samples etc. Because of the compact core reactor concept, which provides for a particularly small H_2O cooled reactor core in the center of a large D_2O moderator tank, high values of the thermal neutron flux can be obtained at only 20 MW power. This paper also discusses some of the features of the technical concepts of the new reactor.

50859 (CONF-9002100–, pp. 13-23) **MITR-III.** Harling, O.K. (Massachusetts Institute of Technology, Cambridge (USA)); Lanning, D.D. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

This paper outlines the successful Massachusetts Institute of Technology (MIT) research project which is currently based on a compact core 5 MW neutron source. In anticipation of the license expiration for the current MITR-II in 1996, studies have been initiated to define the user needs and the reactor design which could meet these needs. An overview of current activities relating to a new or upgraded reactor, MITR-III, are presented in this paper.

50860 (CONF-9002100–, pp. 43-57) **The High Flux Reactor Petten, present status and prospects.** Ahlf, J. (Joint Research Centre, Petten (Netherlands)). Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The High Flux Reactor (HFR) in Petten, The Netherlands, is a light water cooled and moderated multipurpose research reactor of the closed-tank in pool type. It is operated with highly enriched Uranium fuel at a power of 45 MW. Since its first criticality in 1961 the reactor has been continuously upgraded by implementing developments in fuel element technology and increasing the power from 20 MW to the present 45 MW. In 1984 the reactor vessel was replaced by a new one with an improved accessibility for experiments. In the following years also other aging equipment has been replaced (primary heat exchangers, pool heat exchange, beryllium reflector elements, nuclear and process instrumentation, uninterruptable power supply). Control room upgrading is under preparation. A new safety analysis is near to completion and will form the basis for a renewed license. The reactor is used for nuclear energy related research. The beam tubes are used for nuclear physics as well as solid state and materials sciences. Radioisotope production at large scale, processing of gemstones and silicon with neutrons, neutron radiography and activation analysis are actively pursued. A clinical facility for boron neutron capture therapy is being designed at one of the large cross section beam tubes. It is foreseen to operate the reactor at least for a further decade.

50861 (CONF-9002100–, pp. 59-67) **The High Flux Beam Reactor Instrument upgrade.** Axe, J. (Brookhaven National Lab., Upton, NY (USA)). Oak Ridge National Lab., TN (USA). May 1990. DOE Contract AC02-76CH00016. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

A brief overview is given of the current status of the High Flux Beam Reactor, including the ongoing safety review, and of plans for the upgrade of the instruments on the experimental level.

50862 (CONF-9002100–, pp. 69-82) **BER-II upgrade.** Axmann, A. (Hahn-Meitner-Institute Berlin GmbH (West Germany)); Buchholz, H.; Fischer, C.O.; Krohn, H. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The paper gives a brief information on the physical improvements and the technical data of the Berlin Research Reactor BER II, which was upgraded from 1985 until 1990. The licensing procedure is described and the regulations applied.

50863 (CONF-9002100–, pp. 25-41) **The advanced neutron source (ANS) project.** West, C.D. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The Advanced Neutron Source (ANS) is a new user experimental facility for neutron research planned at Oak Ridge. The centerpiece of the facility will be a steady-state source of neutrons from a reactor of unprecedented flux. In addition, extensive and comprehensive equipment and facilities for neutron research will be included. The scientific fields to be served include neutron scattering with cold, thermal, and hot neutrons (the most important scientific justification for the project); engineering materials irradiation; isotope production (including transuranium isotopes); materials analysis; and nuclear science.

50864 (CONF-9002100–, pp. 83-115) **The BR2 materials testing reactor past, ongoing and under-study upgradings.** Baugnet, J.M. (Centre d'Etude de l'Energie Nucleaire Studiecentrum voor Kernenergie, Mol (Belgium)); DeRaedt, C.; Gubel, P.; Koonen, E. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The BR2 reactor (Mol, Belgium) is a high-flux materials testing reactor. The fuel is 93% ^{235}U enriched uranium. The nominal power ranges from 60 to 100 MW. The reactor is used to study the behavior of fuel elements and structural materials intended for future nuclear power stations of several types (fission and fusion). Irradiations are carried out in connection with performance tests up to very high burn-up or neutron fluence as well as for safety experiments, power cycling experiments, and generally speaking, tests under off-normal conditions. Irradiation for nuclear transmutation (production of high specific activity radio-isotopes and transplutonium elements), neutron-radiography, use of beam tubes for physics studies, and gamma irradiations are also carried out. The BR2 is used in support of Belgian programs, at the request of utilities, industry and universities and in the framework of international agreements. The paper reviews the past, and ongoing, and potential upgrading and enhancement of reactor capabilities with regard to reactor equipment, fuel elements, irradiation facilities, reactor operation conditions, and long-term strategy.

50865 (CONF-9002100–, pp. 145-161) **Construction of the upgraded JRR-3 [Japan Research Reactor No. 3].** Matsuura, Shojiro (Japan Atomic Energy Research Institute, Ibaraki (Japan)); Shirai, Eiji; Onishi, Nobuaki. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The construction of the upgraded Japan Research Reactor No.3 (JRR-3) has almost completed. The old reactor was removed from the reactor room, and the new reactor is reconstructed at the place where the old core was. The upgraded reactor is a pool type, 20MW(th), light water moderated and cooled, beryllium and heavy water reflected. Fuels are 20% low enriched UAl_x-Al(LEU) plate type as part of the international Reduced Enrichment for Research and Test Reactors program. Maximum thermal and fast flux are expected to be more than 2×10^{14} n/cm^{2}s. The upgraded JRR-3 has several beam experimental holes and irradiation facilities for multipurpose utilization, including a cold neutron source facility.

50866 (CONF-9002100–, pp. 171-182) **The reactor and cold neutron facility at NIST.** Prask, H.J. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Rowe, J.M. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The National Institute of Standards and Technology Reactor (NBSR) is a 20 MW research reactor located at the Gaithersburg, MD site, and has been in operation since 1969. In the reactor hall there are 26 experimental facilities which are used for materials science, chemical analysis, nondestructive evaluation, neutron standards work, and irradiations. The reactor had built into it from

the beginning a provision for a large volume cold neutron moderator. Utilizing this capability, the Department of Commerce and NIST have begun a project to develop a major national facility for cold neutron research, the CNRF. This $30M project will, when fully completed, provide fifteen new experimental stations with capabilities currently unavailable in this country. It will be operated as a National User Facility, open to all qualified researchers on the basis of scientific merit. One-third of the experimental stations will be provided by sources outside of NIST.

50867 (CONF-9002100–, pp. 183-195) **Upgrade of materials irradiation facilities in HFIR [High Flux Isotope Reactor].** Thoms, K.R.; Montgomery, B.H.; West, C.D. Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

Modifications have been made to the High Flux Isotope Reactor (HFIR) which permit the operation of instrumented irradiation capsules in the target region, and more and larger capsules in the removable beryllium region. As many as two instrumented target capsules can now be accommodated and positions for up to eight 46-mm-diam instrumented capsules are now available in the removable beryllium region. One instrumented target capsule has already been irradiated and new capsules have been prepared for irradiation in the removable beryllium region.

50868 (CONF-9002100–, pp. 197-216) **Backfitting of the FRG-reactors.** Krull, W. (Max-Planck-Strabe, Geesthacht (West Germany)). Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The GKSS research center is operating two research reactors of the swimming pool type fueled with MTR type elements. The research reactors FRG-1 and FRG-2 have power levels of 5 MW and 15 MW, respectively. FRG-1 operates approximately 180 days, and FRG-2 operates between 210 and 250 days per year. Both reactors are located in the same reactor hall in a connecting pool system. Backfitting measures are required for the research reactors to ensure a high level of safety and availability. The paper provides a summary of backfitting activities within the last ten years and a more detailed summary of activities within the last two years, namely, installation of cold neutron source, enrichment reduction for FRG-1 core, fire protection improvements, primary and secondary coolant circuit modifications, and modernization of ventilation systems.

50869 (CONF-9002100–, pp. 117-143) **The Orphee reactor current status and proposed enhancement of experimental capabilities.** Breant, P. (Commissariat a l'Energie Atomique, Saclay (France)). Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

This report provides a description of the Orphee reactor, together with a rapid assessment of its experimental and research capabilities. The plans for enhancing the reactor's experimental capabilities are also presented.

50870 (CONF-9002100–, pp. 217-228) **University research reactors in the United States: Their role and value - From the 1988 study by the National Research Council.** Harling, O.K. (Massachusetts Institute of Technology, Cambridge (USA)). Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

This paper provides a brief overview of the 1988 National Research Council study of the role and value of university research reactors in the US.

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Refer also to citation(s) 50781, 50787, 50851, 50991, 52604

50871 (BF-R–40.039-2.3) **Investigation of fission product retention by the HTR reactor containment according to the vented confinement concept. Technical report 2.3. Aerosol source terms due to graphite corrosion and pressure release as a consequence of water ingress into the modular HTR.** Scheibel, H.G. Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.). Abt. Energietechnik. Jul 1989. 94p. (In German). Contract 03 BT/2010. Source: Copy held by UB/TIB Hannover.

The available data describing the corrosion of the graphitic fuel elements were analysed in this study of the accident scenario of a water ingress into the primary circuit of the modular HTR after rupture of a steam generator tube. Within the scope of an engineering approach for assessment of consequences, the extent of the graphite corrosion is determined, as well as the corresponding radioactivity release from the fuel element, and the dust formation on the fuel element surface. The study also assessed the dust release from the primary circuit in case of a faster pressure release five hours after onset of accident, via an open failure of a safety valve. The source terms for the released aerosol mass and dust-borne activity show values that are by orders of magnitude higher than those obtained by previous analyses, which to some part relied on conservative assumptions due to the meager database available (about 45 kg of dust of the size 2-5 μm, and dust-borne Cs-137 activities of $1.6.10^{10}$ Bq). The conclusion drawn is that this type of accident involves a considerable hazardous potential. (orig.).

50872 (BF-R–40.039-2.4) **Investigation of fission product retention by the HTR reactor containment according to the vented confinement concept. Technical report 2.4. Chemistry and transport of iodine in the reactor containment building of the modular HTR.** Gidarakos, E.; Holzbauer, H.; Thiel, J. Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.). Sep 1989. 92p. (In German). Source: Copy held by UB/TIB Hannover.

Accidents in the modular HTR can lead to leakage of the primary circuit and complete release of the cooling agent from the reactor pressure vessel into the containment building. This process involves release of the radioactive fission iodine which distributes in the containment building and may thus be released to the environment. The work reported here investigates the fission product retention potentials of the containment structures for three representative incident scenarios. Iodine transport and deposition in the containment building are calculated with regard to the different local fluidic and thermohydraulic conditions. (orig.).

50873 (BF-R–40.039-2.6) **Investigation of fission product retention by the HTR reactor containment building according to the vented confinement concept. Technical report 2.6. Study into the filterability of an accidental atmosphere in the modular HTR.** Poss, G.; Fischer, K. Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.). Sep 1989. 65p. (In German). Contract 03 BT/2010. Source: Copy held by UB/TIB Hannover.

A filter for accident management in a modular HTR has to stand peak flow loads of about 10^6 m^3/h over several seconds. The study in hand reports theoretical and materials investigations with a metal fibre filter designed for the LWR type reactor, in order to assess qualification data of a filter that will meet the requirements in a modular HTR. Theoretical results indicate the feasibility of filter surface reduction to technically suitable dimensions, as the aerosols released in a HTR accident are relatively large-sized particles. A problem still to be studied, however, is their filterability at high flow velocities. (DG).

50874 (CONF-900917–17) **The use of PRA [Probabilistic Risk Assessment] in the management of safety issues at the High Flux Isotope Reactor.** Flanagan, G.F. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE91000724. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The High Flux Isotope reactor (HFIR) is a high performance isotope production and research reactor which has been in operation at Oak Ridge National Laboratory (ORNL) since 1965. In late 1986 the reactor was shut down as a result of discovery of unexpected neutron embrittlement of the reactor vessel. In January of 1988, a level 1 Probabilistic Risk Assessment (PRA) (excluding external events) was published as part of the response to the many reviews that followed the shutdown and for use by ORNL to prioritize action items intended to upgrade the safety of the reactor. A conservative estimate of the core damage frequency initiated by internal events for HFIR was 3.11×10^{-4}. In June 1989 a draft external events initiated PRA was published. The dominant contributions from external events came from seismic, wind, and fires. The overall external event contribution to core damage frequency is about 138% of the internal event initiated contribution and is dominated by wind initiators. The PRA has provided a basis for the management of a wide range of safety and operation issues at the HFIR. 3 refs., 4 figs., 2 tabs.

50875 (IAE–4755-3) **Models of reactor core interaction with concretes under serious accidents at NPPs.** Arutyunyan, R.V.; Bol'shov, L.A.; Vasil'ev, A.D. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 24p. (In Russian). Order Number DE91604587. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Mathematical models for description of physical processes of nuclear fuel melt interaction with concrete of biological shield under NPP accident are considered. The concrete destruction time dependence for two-dimensional configuration is determined. It is shown that account of two-dimensional effects causes a significant decrease in concrete melting rate (more than by an order for 13 hours). 6 refs.; 5 figs.; 2 tabs.

50876 (IAE–4778-3) **Simulating reactor vessel meltdown and fuel lowering in concrete under serious accidents at NPPs with WWER reactors using the RASPLAV program complex.** Arutyunyan, R.V. (and others); Bol'shov, L.A.; Goloviznin, V.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 40p. (In Russian). Order Number DE91604658. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The present work is devoted to numerical simulation of interaction between reactor core, reactor vessel and concrete under serious reactor accidents at nuclear power plants. The features of the serious accident simulations are considered. The possibility of keeping the meltdown core in reactor vessel is investigated theoretically and numerically. The process of interaction between the core and concrete constractions is similated numerically. 7 refs.; 22 figs.

50877 (INP–1407/AP) **Radioactivity measurements in Krakow surroundings in the aftermath of Chernobyl reactor accident.** Cywicka-Jakiel, T.; Grychowski, P.; Hajdas, I.; Jasinska, M.; Kolakowski, L.; Loskiewicz, J.; Mazgaj, Z.; Mikulski, J.; Ochab, E. Institute of Nuclear Physics, Cracow (Poland). 1988. 57p. Order Number DE91604241. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A team from different laboratories of the Institute of Nuclear Physics was formed to set a crash program of measurement of water and food contamination after the Chernobyl reactor accident. The main contaminants in the first days were ^{131}I and ^{132}Te which were superseded later on by ^{104}Ru, ^{137}Cs and ^{134}Cs. The highest value of contamination of surface waters by ^{131}I was attained in the Vistula river on the 2-nd of May with 530 Bq/dm^3. Also measurements of food contamination by ^{131}I,^{134}Cs, ^{137}Cs and ^{137}Te were carried out. The additional effective dose equivalent related to Chernobyl accident received by the population of Krakow region in May 1986 was estimated at 0.45 mSV (45 rem). Another rise of ^{134}Cs + ^{137}Cs content up to 46 Bq/dm^3 in cows milk was observed during March and April 1987 and was probably explicable by the use of hay harvested in June 1986. (author).

50878 (JAERI-M–90-083) **Analysis of SCTF/CCTF counterpart test results.** Okubo, Tsutomu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sobajima, Makoto; Iwamura, Takamichi; Ohnuki, Akira; Abe, Yutaka; Adachi, Hiromichi; Murao, Yoshio. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 165p. Order Number DE91712984. Source: NTIS (US Sales Only), PC A08/MF A01.

Slab Core Test Facility (SCTF) and Cylindrical Core Test Facility (CCTF) are large scale experimental facilities of Japan Atomic Energy Research Institute (JAERI) for the investigation of reflooding behavior during a postulated loss-of-coolant accident (LOCA) in PWRs. Although the flow area scaling ratios of both facilities to a 1,000 MWe class PWR are the same and 1/21.4, the SCTF has the same core width as the radius of the reference PWR while the CCTF has a 1/4.5 times shorter core radius. Therefore, a few SCTF/CCTF counterpart tests were conducted in order to investigate the difference in core reflooding behavior between in the SCTF and CCTF tests as well as the effect of core radial length on core two-dimensional thermo-hydrodynamic behavior. This report present the test results and an analysis on them. Major results obtained are: (1) Taking account of the differences in test conditions and facility design, core reflooding behavior is considered to be similar between the SCTF and the CCTF test. Main difference of the facility design is in the effective core flow area and this is considered to result in the difference in core water accumulation behavior. (2) The effect of core radial length on core two-dimensional thermo-hydrodynamic behavior has been observed to be significant and heat transfer enhancement or degradation in radial direction is more significant for the longer radius core. (3) In addition, where the core power varies significantly in the radial direction, significant heat transfer enhancement has been observed in the higher power bundle during the LPCI period. Also, in the peripheral region, heat transfer degradation has been observed more significantly in the outer bundle even they have the same bundle power. (4) Magnitude of these heat transfer enhancement or degradation was larger at the higher elevation than the midplane level in the SCTF test, whereas smaller in the CCTF test. (author).

50879 (JAERI-M–90-085) **Small break LOCA analysis of double-flat-core HCLWR.** Hiraga, Fujio (Hokkaido Univ., Sapporo (Japan)); Suemura, Takayuki; Iwamura, Takamichi; Okubo, Tsutomu; Murao, Yoshio. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 57p. (In Japanese). Order Number DE91712977. Source: NTIS (US Sales Only), PC A04/MF A01.

A double-flat-core high conversion light water reactor (HCLWR) has been developed at JAERI to improve fuel utilization. The HCLWR has two pancake-type cores piled up with lower, internal and upper axial blankets. Fuel rods are arranged in a triangular lattice with p/d = 1.23. The lengths of each core part and each blanket part are 60 cm and 30 cm, respectively. As a part of the thermal-hydraulic feasibility study of the present design, a small break loss-of-coolant accident (SBLOCA) analysis has been performed with a best-estimate code J-TRAC. The break location was selected to be the instrumentation pipes connected to the lower plenum because the highest core temperature was observed in the lower plenum break test in the LSTF SBLOCA experiments, which were performed under the ROSA-IV project in JAERI. The break area was corresponding to 0.5 % of the cold leg flow area. The analytical results showed: (1) Although an intermittent actuation of the accumulator injection system was observed, the water level in the core was gradually recovered and finally the core recovery was assured by balancing the safety injection flow rate and the discharge flow rate. (2) The maximum clad temperature was 1265 K during the transient. Since the peak clad temperature was much lower than the present regulatory limit of 1473 K and the long term core cooling was assured, the present HCLWR is considered to be feasible from a view point of the SBLOCA. The moderate temperature rise after dryout is mainly due to the features of the present design such as the lower axial peaking factor and the larger water inventory in the upper plenum which leads to the delay of core dryout and reducing the decay heat level. (author).

50880 (MIC–90-04268/XAB) **Nuclear Emergency Plan, Part VII: Darlington.** Government of Ontario, Toronto, ON (Canada). ©1989. 73p. Source: NTIS, PC EE07/MF E01.

Plan prescribing the measures to be taken to deal with a nuclear emergency caused by the Darlington Nuclear Generating Station. The plan deals mainly with actions at the provincial level, supplemented by those at the municipal level. This plan includes a

general municipal plan and joint traffic control plan; data and organization of zones, response sectors, facilities, and telecommunications; notification; phase I and II operations, including evacuation, worker safety, monitoring and restoration; actions to be taken in the case of liquid emissions; and information and public direction, including the establishment of designated media and a local information centre.

50881 (MIC–90-04269/XAB) **Nuclear Emergency Plan, Part VI: Enrico Fermi 2.** Government of Ontario, Toronto, ON (Canada). ©1989. 92p. Source: NTIS, PC EE07/MF E01.

Plan dealing with actions to be undertaken at the provincial and municipal levels in Ontario to deal with a nuclear emergency caused by the Enrico Fermi 2 nuclear plant in Monroe County, Michigan, U.S.A. The plan covers the operations of the participating organizations in both Michigan and Ontario; notification; phase I and II actions; necessary actions in case of liquid emissions; and emergency information and public direction.

50882 (NEAG–1TP4B-90009-(Vol.1)) **SPES experimental program: OECD/CSNI ISP22 draft comparison report. 4 Volumes.** De Toma, G.; Ederli, S.; Negrenti, E.; Marsili, P. ENEA, Casaccia (Italy). Dipt. Reattori Termici. Mar 1990. 257p. Order Number DE91712726. Source: NTIS (US Sales Only), PC A12/MF A01.

The OECD-CSNI International Standard Problem 22 is a 'Loss of Feedwater with EFW (emergency feedwater) delayed' test, performed in the SPES (PWR simulator for reactor safety performance tests) facility (SIET-Piacenza). It is a double blind exercise, characterized by a large participation of non-OECD countries sponsored by the IAEA. The Draft Comparison Report is based on two fundamental elements: the comparison between the single Participants predictions and the experimental data, and the overall comparison among all calculations and test results. The conclusions drawn from these analyses highlight the major contributions to the observed discrepancies deriving from code limitations, user errors, experimental uncertainties. From a macroscopic point of view, it is concluded that most of the phenomena occurring in the ISP22 experiment were generally predicted by the double blind predictions. A more accurate analysis of the single phenomena can nevertheless reveal relevant discrepancies between calculations and data. The document also contains a description of ISP22 Participants and input decks, and a collection of their comments on the differences between calculation and test results.

50883 (NORD–1990-30) **Some studies related to decommissioning of nuclear reactors.** Bergman, C. (National Inst. of Radiation Protection, Stockholm (Sweden)); Menon, S. Nordisk Kontaktorgan for Atomenergispoergsmaal, Risoe (Denmark). Feb 1990. 48p. Project NKA KAV 350. Order Number DE91604797. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Decommissioning of large nuclear reactors has not yet taken place in the Nordic countries. Small nuclear installations, however, have been dismantled. This NKA-programme has dealt with some interesting and important factors which have to be analysed before a large scale decommissioning programme starts. Prior to decommissioning, knowledge is required regarding the nuclide inventory in various parts of the reactor. Measurements were performed in regions close to the reactor tank and the biological shield. These experimental data are used to verify theoretical calculations. All radioactive waste generated during decommissioning will have to be tansported to a repository. Studies show that in all the Nordic countries there are adequate transport systems with which decommissioning waste can be transported. Another requirement for orderly decommissioning planning is that sufficient information about the plant and its operation history must be available. It appears that if properly handled and sorted, all such information can be extracted from existing documentation. (authors).

50884 (NUREG/CR–3469-Vol.5) **Occupational dose reduction at nuclear power plants: Annotated bibliography of selected readings in radiation protection and ALARA: Volume 5.** Khan, T.A. (Brookhaven National Lab., Upton, NY (USA)); Tan, H.; Baum, J.W.; Dionne, B.J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications; Brookhaven National Lab., Upton, NY (USA). Sep 1990. 92p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–51708-Vol.5). Source: NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

One of the functions of the ALARA Center is to collect and disseminate information on dose reduction at nuclear power plants. This is the fifth report in the series of bibliographies of selected readings in radiation protection and ALARA that the center publishes periodically. The abstracts in this bibliography were selected from proceedings of technical meetings, journals, research reports, searches of information data bases and reprints of published articles provided to us by the authors. The abstracts relate in one way or another to dose reduction at nuclear power plants, whether it is through good water chemistry, improvements in nuclear materials, better control of corrosion, robotics, and remote tooling or good operational health physics. The report contains 278 abstracts. Subject and author indices are provided. The subject index covers all previous volumes in this series. All information in the current volume is also available from the ALARA Center's on-line service, which is accessible by personal computer with the help of a modem. The preface of the report explains how the service may be accessed. The on-line service will be updated as new information is received.

50885 (NUREG/CR–5597) **In-vessel Zircaloy oxidation/hydrogen generation behavior during severe accidents.** Cronenberg, A.W. (Science and Engineering Associates, Inc., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Engineering Science and Analysis, Albuquerque, NM (USA). Sep 1990. 56p. Sponsored by Nuclear Regulatory Commission. Source: NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

In-vessel Zircaloy oxidation and hydrogen generation data from various US Nuclear Regulatory Commission severe-fuel damage test programs are presented and compared, where the effects of Zircaloy melting, bundle reconfiguration, and bundle quenching by reflooding are assessed for common findings. The experiments evaluated include fuel bundles incorporating fresh and previously irradiated fuel rods, as well as control rods. Findings indicate that the extent of bundle oxidation is largely controlled by steam supply conditions and that high rates of hydrogen generation continued after melt formation and relocation. Likewise, no retardation of hydrogen generation was noted for experiments which incorporated control rods. Metallographic findings indicate extensive oxidation of once-molten Zircaloy bearing test debris. Such test results indicate no apparent limitations to Zircaloy oxidation for fuel bundles subjected to severe-accident coolant-boiloff conditions. 46 refs., 22 figs., 12 tabs.

50886 (NUREG/CR–5616) **Auxiliary feedwater system risk-based inspection guide for the Diablo Canyon Unit 1 Nuclear Power Plant.** Gore, B.F.; Vo, T.V.; Harrison, D.G. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Radiation Protection and Emergency Preparedness; Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 24p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–7351). Source: NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

This document presents a compilation of auxiliary feedwater (AFW) system failure information which has been screened for risk significance in terms of failure frequency and degradation of system performance. It is a risk-prioritized listing of failure events and their causes that are significant enough to warrant consideration in inspection planning at Diablo Canyon. This information is presented to provide inspectors with increased resources for inspection planning at Diablo Canyon. The risk importance of various component failure modes was identified by analysis of the results of probabilistic risk assessments (PRAs) for many pressurized water reactors (PWRs). However, the component failure categories identified in PRAs are rather broad, because the failure data used in the PRAs is an aggregate of many individual failures having a variety of root causes. In order to help inspectors to focus on specific aspects of component operation, maintenance and design which might cause these failures, an extensive review of component failure information was performed to identify and rank the root causes of these component failures. Both Diablo Canyon and industry-wide failure information was analyzed. Failure causes

were sorted on the basis of frequency of occurrence and seriousness of consequence, and categorized as common cause failures, human errors, design problems, or component failures. This information permits an inspector to concentrate on components important to the prevention of core damage. Other components which perform essential functions, but which are not included because of high reliability or redundancy, must also be addressed to ensure that degradation does not increase their failure probabilities, and hence their risk importances. 23 refs., 1 fig., 1 tab.

50887 (NUREG/CR–5622) **Analysis of reactor trips originating in balance of plant systems.** Stetson, F.T. (Science Applications International Corp., McLean, VA (USA)); Gallagher, D.W.; Le, P.T.; Ebert, M.W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Technology; Science Applications International Corp., McLean, VA (USA). Sep 1990. 210p. Sponsored by Nuclear Regulatory Commission. (SAIC–89/1148). Source: NTIS, PC A10/MF A01 - GPO; OSTI; INIS.

This report documents the results of an analysis of balance-of-plant (BOP) related reactor trips at commercial US nuclear power plants of a 5-year period, from January 1, 1984, through December 31, 1988. The study was performed for the Plant Systems Branch, Office of Nuclear Reactor Regulation, US Nuclear Regulatory Commission. The objectives of the study were: to improve the level of understanding of BOP-related challenges to safety systems by identifying and categorizing such events; to prepare a computerized data base of BOP-related reactor trip events and use the data base to identify trends and patterns in the population of these events; to investigate the risk implications of BOP events that challenge safety systems; and to provide recommendations on how to address BOP-related concerns in regulatory context. 18 refs., 2 figs., 27 tabs.

50888 (ORNL/CSD/FTR–3758) **Surveillance data bases, analysis, and standardization program: Foreign trip report, August 23, 1990–September 13, 1990.** Kam, F.B.K. Oak Ridge National Lab., TN (USA). 26 Sep 1990. 18p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE91000684. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler presented a paper at the Seventh ASTM-EURATOM Symposium on Reactor Dosimetry and co-chaired an oral session on Computer Codes and Methods. Papers of considerable interest to the NRC Surveillance Dosimetry Program involved statistically based adjustment procedures and uncertainties. The information exchange meetings with Czechoslovakia and Hungary were very enlightening. Lack of large computers have hindered their surveillance program. They depended very highly on information from their measurement programs which were somewhat limited because of the lack of sophisticated electronics. The Nuclear Research Institute at Rez had to rely on expensive mockups of power reactor configurations to test their fluence exposures. Computers, computer codes, and updated nuclear data would advance their technology rapidly, and they were not hesitant to admit this fact. Both eastern-bloc countries said that IBM is providing an IBM 3090 for educational purposes but research and development studies would have very limited access. They were very apologetic that their currencies were not convertible, and any exchange means that they could provide services or pay for US scientists in their respective countries, but funding for their scientists in the United States, or expenses that involved payment in dollars, must come from us.

50889 (PSI–72) **OECD-LOFT large break LOCA experiments: phenomenology and computer code analyses.** Brittain, I. (UKAEA Atomic Energy Establishment, Winfrith (UK)); Aksan, S.N. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Aug 1990. 44p. Order Number DE91604589. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Large break LOCA data from LOFT are a very important part of the world database. This paper describes the two double-ended cold leg break tests LP-02-6 and LP-LB-1 carried out within the OECD-LOFT Programme. Tests in LOFT were the first to show the importance of both bottom-up and top-down quenching during blowdown in removing stored energy from the fuel. These phenomena are discussed in detail, together with the related topics of the thermal performance of nuclear fuel and its simulation by electric fuel rod simulators, and the accuracy of cladding external thermocouples. The LOFT data are particularly important in the validation of integral thermal-hydraulics codes such as TRAC and RELAP5. Several OECD partner countries contributed analyses of the large break tests. Results of these analyses are summarised and some conclusions drawn. 32 figs., 3 tabs., 45 refs.

50890 (SAND–90-2251C) **Detonation cell widths in hydrogen-air-diluent mixtures.** Stamps, D.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 18p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (CONF-9010207–1: 1990 combustion institute fall meeting, San Diego, CA (USA), 14-16 Oct 1990). Order Number DE91000771. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper I report on the influence of steam and carbon dioxide on the detonability of hydrogen-air mixtures. Data were obtained on the detonation cell width in a heated detonation tube that is 0.43 m in diameter and 13.1 m long. The detonation cell widths were correlated using a characteristic length calculated from a chemical kinetic model. The addition of either diluent to a hydrogen-air mixture increased the cell width for all equivalence ratios. For equal diluent concentrations, however, carbon dioxide not only yielded larger increases in the cell width than steam, but its efficacy relative to steam was predicted to increase with increasing concentration. The range of detonable hydrogen concentrations in a hydrogen-air mixture initially at 1 atm pressure was found to be between 11.6 percent and 74.9 percent for mixtures at 20°C and 9.4 percent and 76.9 percent for mixtures at 100°C. The detonation limit was between 38.8 percent and 40.5 percent steam for a stoichiometric hydrogen-air-steam mixture initially at 100°C and 1 atm. 10 refs., 4 figs., 1 tab.

24 POWER TRANSMISSION AND DISTRIBUTION

Refer also to citation(s) 50756

50891 (ORNL/FTR–3744) **[Insulating materials and large high voltage electric systems]: Foreign trip report, August 24, 1990–September 5, 1990.** Dale, S.J. Oak Ridge National Lab., TN (USA). 18 Sep 1990. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90017851. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the 33rd Session of CIGRE (The International Conference on Large High Voltage Electric Systems in Paris, France) as a US technical expert advisor the Study Committee 15, Insulating Materials. Over 200 papers were discussed, contributed from over 45 countries at the conference on all aspects of electric power generation and transmission. Of special interest was a panel session on superconducting technology for electric power systems and the participation on a new task force on the electrical insulation at cryogenic temperatures. Significant insight was gained into the development of superconducting power technologies in Europe and Japan. CIGRE has set up a committee to follow the development in research on the biological effects of electric and magnetic fields. The traveler also visited the Centre for Electric Power Engineering at the University of Strathclyde, Glasgow, Scotland and discussed research on degradation of polymeric cable insulation and gas insulated equipment. 5 refs.

2401 Power Systems

Refer also to citation(s) 50992

50892 (EPRI-EL–6960) **Fundamental research on metal oxide varistor technology: Final report.** Ellis, H.F.; Reckard, R.M.; Phillipp, H.R.; Nied, H.F. Electric Power Research Inst., Palo Alto, CA (USA); General Electric Co., Pittsfield, MA (USA). ©Aug 1990. 67p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The object of this program was to do fundamental research on zinc-oxide-based ceramic arrester disks with the goals of improving the energy-handling capability, watts loss (especially at 200°C),

and the nonlinear exponent, α. The consequences of reaching the goals would be to reduce the number of parallel columns in the varistor unit used in series capacitor protection by a factor of three. Or given the additional energy-handling capability, eliminate the parallel trigger gap and associated controls used to bypass the varistor during extreme system faults. In the case of standard station arrester applications, the improvement in energy-handling capability could lead to designs with a one-third reduction in the zinc oxide volume while maintaining the same performance characteristics of a larger diameter disk. But having increased energy flow through a given size disk or one of decreased volume raises the temperature of the disk. This in turn increases the watts loss generated by the disk and thus another objective was to develop a formulation that would lower the watts lost by at least 70% at 200°C to prevent thermal runaway of the arrester. For the standard station arrester, a decrease in the volume by decreasing the cross-sectional area also requires at least a 10% increase in the nonlinear exponent to maintain the same protective level. All the objectives were met and in addition a technique was developed for using infrared thermography to calculate the thermal stresses in a disk subjected to sudden joule heating. This program generates curves for the optimum size disk given the energy input and the thermal boundary conditions. 31 figs.

50893 (OME–CE03083) **Innovations in distribution load management: Seminar proceedings.** Ontario Ministry of Energy, Toronto, ON (Canada). 1989. vp. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

A seminar was held to discuss innovations in distribution load management. Papers on load management technology and case studies were presented. Separate abstracts have been prepared for 8 papers from this seminar.

50894 (OME–CE03083, pp. 1-29) **Distribution processing SCADA [supervisory control and data acquisition] system.** Jackson, E. (Cornwall Electric, ON (Canada)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

Cornwall Electric installed a load management system that was able to interface with a SCADA (supervisory control and data aquisition) system. The system consisted of a standard IBM computer as the master station which talked to standard IBM clones at each of the 6 substations. The engineering information structure links the accounting data system which includes the metering data, the historic engineering data system topology, the SCADA system, and the load management system. This allows Cornwall Electric to: configure the system to minimize losses through an engineering package based on current loads and system topology; predict when peaks will occur with more accuracy and identify weak spots in the distribution system to allow for more appropriate use of load control devices; and predict duration of peaks and determine the most effective way of minimizing them. Last year in the month of January alone, Cornwall Electric was able to reduce its demand charge by over $50,000 by reducing voltage to the bottom end of the CSA standard for 3 hours during the peak demand. This equipment was able to predict when the peak was to occur within 15 minutes. Aside from the energy management aspects of the SCADA system the safe operation of the distribution system has been markedly increased. Field personnel are using more non-reclosure assurances (hold-offs) and areas can be isolated more quickly. A better understanding of the load allows the staff to plan future expansion with a better handle on the system. Because Cornwall Electric purchases power on the international market, the additional information that the SCADA system provides allows for the negotiation of much more cost effective contracts with their suppliers. 4 figs.

50895 (OME–CE03083, pp. 1-19) **Load management for northern utilities.** Elliot, R. (Energy Management Engineering, Pembroke, ON (Canada)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

This paper describes the utility load management system designed for and installed in the town of Deep River, Ontario. Utility load management was considered by Deep River Hydro because it has the second highest retail rates in eastern Ontario. After a preliminary review of institutional, commercial and residential loads, it was concluded that many could be deferred during utility peak periods, to reduce the billing demand and therefore the wholesale cost of power. It was recognized that customers' discounts would be necessary to encourage participation. After review of commercially available, computer based systems, the Scientific Atlanta system, employing a dedicated FM transmitter, was chosen. This decision was based on its versatility, low cost and ten years of proven experience in U.S. utilities. After the system was ordered, cutomers' loads were selected and evaluated to complete the system detailed design, estimate utility savings and develope customers' discounts. System installation and commissioning was started in late August 1988. A description of the load management system, controlled loads, utility savings and customers' discounts is provided. Results reveal a 7% maximum possible increase in average annual load factor. The estimated system payback based on net annual utility savings of $103,743 is approximately equal to one year. Continuous operation for one year, with most of the selected loads under control, will be necessary for a realistic comparison of actual and predicted performance. System tests will be performed early in 1990 to determine the actual winter performance. 2 figs., 12 tabs.

50896 (OME–CE03083, pp. 1-6) **Large scale applications of load management.** Young, F.S. (Electric Power Research Inst., Palo Alto, CA (USA)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

Load management in its traditional sense deals with control of the customers' load to shift peaks or provide incentives for using electric service at different times of the day. A much broader concept of load management, however, can be visualized in the context of new, emerging technologies which may solve some problems inherent in the present network design and in offering new services to utility customers. Power electronic control of current flow may allow increased loading of existing circuits and facilitate an increasing number of transactions among utilities. Computer and communication advances will contribute to operation of systems closer to their design limits. Also, the longer term discoveries such as high temperature ceramic superconductors may revolutionize the way power is delivered to utility customers.

50897 (OME–CE03083, pp. 1-9) **Increasing environmental and economic considerations for load management.** Mansueti, L. (American Public Power Association, Washington, DC (USA)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

This paper discusses economic and environmental pressures that force utilties to turn to demand-side options. Demand-side options such as load management increase energy efficiency, which helps ensure both environmental protection and economic well being. Demand-side programs, which deliberately modify load shapes, offer utilities a flexible strategy for operating efficiently and effectively in uncertain and competitive environments. Load management is flexible in adaptation, permits testing through comparatively inexpensive pilot projects, and can be introduced in

small increments tailored to meet particular problems. It allows consumers to make choices by unbundling the package of firm requirements sales which is the more traditional offering by utilities. It has a short lead time, exhibits immediate results, and may provide a fast pay-back. It is a way of beating market/regulatory risk which jeopardizes other investments. Actual experiences with load management are described.

50898 (OME–CE03083, pp. 1-4) **Load management as an element of distribution system management.** McCaull, L.V. (Ontario Hydro, Toronto, ON (Canada)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

Load management is an important means to achieve highly desirable improvements in the efficiency of electrical energy delivery. It has been successfully implemented by utilities for several decades to reduce load peaks, and consequently reduce the cost of power purchased, as well as to avoid or delay capital expenditures necessary for increases in capacity. This paper outlines the concept of a comprehensive process for managing the operation of a distribution system, in which load management is an important element. Load management is executed by remotely controlling individual customer loads to achieve desired reductions in aggregate system loads, without inconveniencing the affected customers. Appropriate suppression or biasing of cyclical loads on a rotating basis, or exploitation of energy storage facilities are commonly employed techniques. A systematically conceived, and executed system management process can provide for maximum utilization of a utility's physical plant, as well as enhancing the quality of service to its customers.

50899 (OME–CE03083, pp. 1-16) **Load management: A design and operations perspective.** Carr, J. (Acres International Ltd. (Canada)); Albert, R.A. Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

In recent years the utility industry has been placing increasing emphasis on managing customer loads to reduce the system peak in order to displace new generation facilities or decrease demand charges. Many distribution utilities will consider and adopt some form of load control in order to modify their system load curves to reduce their cost of purchased power. These load control strategies may involve direct methods for turning on and off customers' loads by remote control or they may be based on indirect methods using incentive rate structures such as time-of-use rates at the retail level. This paper explores some of the impacts load management activities will have on the distribution system itself and on its operation. Topics covered include identification of controllable loads, rebound demand and deferred energy, system hierarchy and impacts, mitigation of the impact on distribution facilities, cost of load management and some of the distribution engineering challenges that go along with the introduction of load management. It is important that utilities planning load management systems consider not only the behavior of their customers and the cost of wholesale power from Ontario Hydro but also the impact on their substations, feeders and transformers.

50900 (OME–CE03083, pp. 1-19) **Microcomputer systems technology for load management.** Fish, L. (Jomitek Inc., Nepean, ON (Canada)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

Load management, a technique of controlling loads on a distribution system to avoid buying high priced power during peak periods, has been identified as a principal means of reducing rising operating costs and improving the efficiency of operations in Ontario. The personal computer has become the ideal candidate for load management applications due to its low cost, high performance, high reliability, flexibility, multiple sourced standard parts, and its need for minimal maintenance. They have the inexpensive computing power required to: record the large amounts of data required for load management; characterize electrical energy consumption from historical data; compute complex mathematical demand forecast models; dedicate a computer system to the task of load management; use real demand forecasting techniques to accurately determine in advance the time and magnitude of a system peak; use rule based control systems to most effectively implement load controls; and implement complex load cycling schedules to avoid the economic pitfalls of demand fly back.

50901 (OME–CE03083, pp. 1-6) **Water heater load control: Experience with power line carrier and FM/SCA systems.** Anderson, S. (Westinghouse ABB Power T&D Co., Raleigh, NC (USA)). Ontario Ministry of Energy, Toronto, ON (Canada). 1989. (CONF-8911242–: Innovations in distribution load management, Toronto (Canada), 29 Nov 1989; CE–03083). In *Innovations in distribution load management: Seminar proceedings.* vp. Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

This paper discusses a variety of new products and systems which are now available for utilities to use in addressing their needs in the areas of load management, demand-side strategies such as TOU (time of use) metering, and automated distribution. Special emphasis is given to one-way and two-way radio systems which employ the subsidary carrier of commercial FM radio stations for automated distribution and load management applications. These systems are described in terms of their equipment and capabilities.

50902 (PB–90-257452/XAB) **Bulk system reliability screening analysis. Final report.** Fink, L.H.; Mescua, J. Carlsen and Fink Associates, Inc., Fairfax, VA (USA). 30 Sep 1989. 49p. Grant NSF-ISI-8603070. Source: NTIS, PC A03/MF A01.

The report describes a new methodology for bulk power (composite) system reliability screening analysis. A novel formulation of the reliability problem is provided. A structural adequacy index (SAI) is defined and evaluated at a sufficient number of points on a seasonal load duration curve that its average value over the season can be determined. The effects of all higher level contingencies that include lower order critical contingencies are taken into account. By tracking to steady state the geometric mean of upper and lower bounds of the SAI, the asymptotic value of the SAI is estimated. The methodology is illustrated by examples using the IEEE Reliability Test System and the EPRI Scenario D System.

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 50906, 50992

50903 Mutual coupling between horizontal earth return conductors using actual routing parameters. Rogers, E.J. (Bonneville Power Administration, MKTP, P.O. Box 491 Vancouver, WA (US)); White, J.F. *IEEE Transactions on Power Delivery (Institute of Electrical and Electronics Engineers) (USA),* 5(3): 1266-1274 (Jul 1990).

Formula for calculating mutual coupling between diversely routed, horizontal earth-return conductors used in the measurement of grounding system impedance is derived by using the complex ground plane concept used to approximate the Carson Equation. Each potential conductor section is approximated with equal length segments that parallel one of the current conductor sections. By repeating the parallel segmentation of each potential conductor section with each subsequent current conductor section and summing the segment mutuals, overall mutual between diversely routed

conductors is obtained. This process is useful for calculating mutual to the potential conductor and for comparing possible potential conductor routings so as to minimize the overall mutual coupling.

50904 Steep front impulse flashover tests on a solid-state relay. Salas, T.M. (BDM International, Inc., Albuquerque, NM (US)); Wiggins, C.M.; Barnes, P.R. *IEEE Transactions on Power Delivery (Institute of Electrical and Electronics Engineers) (USA)*, 5(3): 1281-1287 (Jul 1990). DOE Contract AC05-84OR21400.

A protective relay system, subjected to a high voltage steep front impulse, has been shown to fail in the laboratory via flashover induced current flow through on the DC power supply. Laboratory experiments were performed to characterize the response of a protective relay to steep front impulses. These impulses may be the result of a nuclear induced high altitude electromagnetic pulse. Tests were also conducted to quantify the protection offered by a surge protection package on the DC circuits of a relay system. Results from these tests are used to assess the vulnerability of a protective relay.

50905 Examination of Grizzly Mountain data base to determine effects of relative air density and conductor temperature on HVDC corona phenomena. Chartier, V.L. (Bonneville Power Administration, Vancouver, WA (US)); Stearns, R.D. *IEEE Transactions on Power Delivery (Institute of Electrical and Electronics Engineers) (USA)*, 5(3): 1575-1582 (Jul 1990).

This paper summarizes the results of an effort to determine the effect of relative air density (RAD) and conductor temperature on HVDC corona phenomena by statistically examining fair weather audible noise (AN), radio noise (RI), ion-enhanced electric field, and ion current density data in the 1986 data base from the Grizzly Mountain HVDC research project. Since wind has such a strong effect on dc electric fields and ions, this comparison was made under no-wind conditions; wind speeds less than 1 m/s. The results of this effort demonstrated that AN, RI, negative electric field, and negative ion current density increase with increasing ambient and conductor temperature and decrease with increasing RAD. However, positive electric fields and positive ion current densities showed essentially no correlation with either conductor temperature or RAD.

2403 Power Transmission Lines and Cables

50906 (EPRI-EL–6933) **Development of 230-kV high-pressure, gas-filled, pipe-type cable system: Model test program phase.** Silver, D.A. (Pirelli Cable Corp., Florham Park, NJ (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Pirelli Cable Corp., Florham Park, NJ (USA). ©Sep 1990. 109p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The objective of this project was the development of a 230 kV high-pressure gas-filled (HPGF) pipe-type cable employing paper or laminate of paper-polypropylene-paper (PPP) insulation pressurized with N_2 gas or a blend of 15% SF_6/85% N_2 gas. Heretofore, HPGF pipe-type cables have been restricted to 138 kV ratings due to technical difficulties in achieving higher voltage ratings. In view of the high cost of manufacturing and testing a large number of full size cables, cable models with 2 mm (80 mils) and 2.5 mm (100 mils) wall thicknesses of insulation enclosed in a test fixture capable of withstanding a test pressure of 2070 kPa (300 psig) and high electrical stresses were employed for dissipation factor versus voltage measurements and for ac and impulse breakdown tests at rated and emergency operating temperatures. In addition, a 36 cm (14 in) full wall cable model enclosed in a pressure vessel was utilized for transient pressure response tests. The results of this investigation attest tot he technical feasibility of the design and manufacture of a 230 kV HPGF pipe-type cable employing paper or PPP insulation pressurized with 100% N_2 gas or a blend of 15% SF_6/85% N_2 gas for operation under normal and 100 hour emergency conditions at conductor temperatures of 85° and 105°C, respectively. The manufacture of a full size PPP insulated cable pressurized with a blend of 15% SF_6/85% N_2 gas employing preimpregnated PPP insulating tapes and an annular conductor based on the design stresses defined in this report is recommended for laboratory evaluation and extended life tests. 11 refs., 45 figs., 11 tabs.

50907 (OH/TD–87201) **Electrical supply to OWMC [Ontario Waste Management Corporation]: Environmental study report.** Ontario Hydro, Toronto, ON (Canada). Transmission Design Dept. Nov 1987. 108p. (MICROLOG–90-02866). Source: PC Ontario Waste Management Corporation, 2 Bloor St. West, 11th. Fl., Communications Service, Toronto, ON, CAN M4W 3E2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This document describes the technical, economic and environmental studies carried out by Ontario Hydro to plan the new transmission facilities required to supply electrical energy to the proposed Ontario Waste Management Corporation Industrial Waste Treatment and Disposal Facility (OWMC Facility) in the Township of West Lincoln. As a result of these studies, approval is being sought for transmission facilities including approximately 3.3 km of a single circuit, 115 kV, wood poles transmission line; 2 line taps and manually - operated switches to energize and operate the new line; and the raising of an existing 230 kV transmission line to provide electrical clearance for the egress of the new transmission line. The 3 options considered in the studies are compared as to their cost and electrical planning convenience. The environment of the transmission facility is described, and the requirements of the right-of-way are summarized. The recommended route for the transmission line is environmentally preferred over other route alternatives, since it has less overall effect on farm operations and agricultural resources; it avoids transmission line construction and maintenance in a provincially significant wetland area; it avoids special construction and maintenance practices to preserve specimens and habitat of a provincially rare shrub; and it has less effect on forest resources. The net environmental and aesthetic impacts of constructing, operating and maintaining the proposed transmission facilities are expected to be minor to negligible, following the application of standard mitigation and restoration measures. Public involvement in and modification of the project are discussed. A glossary of technical terms is provided. 21 refs., 16 figs., 8 tabs.

2404 Health and Safety

50908 (DOE/CE/34025–T5) **Further studies of 60 Hz exposure effects on human function: Quarterly report No. 5, July 1, 1990–September 30, 1990.** Graham, C.; Cohen, H.D. Midwest Research Inst., Kansas City, MO (USA). 9 Oct 1990. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE34025. Order Number DE91000868. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Public concern has been expressed about possible health risks arising from exposure to the electric and magnetic fields generated power distribution systems. This project is addressing this concern through a laboratory research program designed to evaluate the effects of brief exposure to known field conditions on multiple measures of human function. In previous research, we found that exposure had statistically significant effects on physiological measures of cardiac and brain activity, and on performance measures of reaction time and performance accuracy. Effects were seen more clearly under intermittent exposure conditions, and at certain levels of electric and magnetic field strength. In this continuation effort, we are performing a series of exploratory studies, to be followed by a confirmatory experiment, to determine if the above physiological effects differ as a function of exposure to the electric and magnetic fields separately and combined, time of day, and rate of intermittent exposure. Further studies will explore the mechanisms underlying these effects. The information developed in this project will be of value in risk assessment activities, and in basic research aimed at identifying specific factors involved in the interaction of power line fields with the human system. In this reporting period our goals were to: (a) continue performance of the probe studies; (b) participate in a site visit at MRI; (c) request 1991 research continuation funding; and (d) submit an abstract of project findings for presentation at the 1990 DOE Contractors Review Meeting.

2405 Environmental Aspects

Refer also to citation(s) 50907

2406 Legislation and Regulations

Refer also to citation(s) 51002

50909 (NEB-SS-132-1) **Memorandum of guidance to interested parties concerning full implementation of the September 1988 Canadian electricity policy.** National Energy Board, Ottawa, ON (Canada). 22 Jun 1990. vp. (CE-03125). Source: National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C.

As a result of new provisions in the Amended Act on international power lines and electricity exports, which came into force June 1, 1990, the National Energy Board proposed new regulations dealing exclusively with electricity. This memorandum informs interested parties of the measures the Board intends to take to fully implement the Amended Act and, in particular, to advise parties of immediate changes to procedures for export of electricity and international power line applications. Under the amended Act, electricity exports and international power lines will normally be authorized by the issuance of a permit without a public hearing, unless a proposed export or international power line is designated for licensing or certification procedures. In the case of a proposed export, considerations include the effect of the export on provinces outside the sponsoring province; the impact of the export on the environment; and whether Canadians interested in purchasing to satisfy their own requirements have been afforded fair market access to the electricity proposed for export. In the case of a proposed international power line, considerations include the effect of the line on provinces other than those through which the line is to pass and the impact of the construction or operation of the line on the environment. Detailed routing and land acquisition for international power lines will be carried out under provincial laws unless an applicant elects to have federal laws apply. Appendices include the regulations, guidelines for the environmental information required for international power lines, and directions on procedure.

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50909, 51024

50910 (EPRI-CU-6924-Vol.1) **DSM [demand-side management]: Transmission and distribution impacts: Volume 1, Analysis framework and test case: Final report.** Willis, H.L. (ABB Power Systems, Inc., Pittsburgh, PA (USA)); Vogt, L.J.; Huff, R.G.; Pettyjohn, W.R. Electric Power Research Inst., Palo Alto, CA (USA); ABB Power Systems, Inc., Pittsburgh, PA (USA); Southern Electric International, Atlanta, GA (USA). ©Aug 1990. 127p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report addresses the issues concerning transmission and distribution (T&D) impacts that would result from the implementation of demand-site management (DSM) programs. These issues include effects on the T&D facilities and on the T&D system planning process. The report reviews traditional T&D planning methods and then focuses on procedural changes necessary to fully integrate DSM strategy analysis with the system planning process. The modified process incorporates a screening method that can be applied quickly and economically to make general evaluations of potential T&D impacts when a multitude of DSM scenarios are under consideration. A framework for such an integrated T&D system planning process is presented. Test procedures and results are discussed for a study conducted at a host utility. Several DSM strategies were analyzed to assess the impacts on a T&D system serving a large metropolitan area. This investigation proceeded by applying both a detailed, optimization-based analysis methodology as well as a screening methodology known as Spatial Frequency Analysis (SFA). The results of the SFA study paralleled the results of the detailed study, thereby supporting SFA as an effective T&D impact screening tool. The report concludes with recommendations and guidelines for studying DSM strategies and suggests ways to evaluate the T&D costs and benefits associated with such programs. 20 refs., 29 figs., 10 tabs.

50911 (MH-90-04957) **Perspective 2000.** Manitoba Hydro, Winnipeg, MB (Canada). Dec 1989. 81p. (MICROLOG-90-04957). Source: PC Manitoba Legislative Library, 200 Vaughan St., Winnipeg, MB, CAN R3C 1T5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This booklet summarizes the pressures and influences Manitoba Hydro faces, and how it plans to respond to them over the next 10 years. After discussing the corporate, environmental, energy, and physical environments which affect the utility, the booklet describes domestic and export customers and markets. Planning assumptions and criteria are given. The need for additional generation, options for supply, internal operations and the corporation's financial management are discussed. A glossary is included. 68 figs.

25 ENERGY STORAGE

2506 Thermal

Refer also to citation(s) 50731, 51065, 51270

50912 (BFR-D-12-1990) **A borehole heat store in rock at the University of Luleaa: The Lulevaerme project 1982-1988.** Nordell, B. (Luleaa Univ., (SE). Div. of Water Resources Engineering). Swedish Council for Building Research, Stockholm (Sweden). Dec 1989. 52p. Project BFR-820396-7. Order Number DE91707892. Source: NTIS (US Sales Only), PC A04/MF A01.

The store, which was the first large-scale borehole heat storage in the world, was built in 1982-1983. The University of Luleaa has monitored the performance of the heat store from 1983 to 1988. Performance of the store has been modelled by the Lund Inst. of Technology. The store supplies heat during the winter to one of the University buildings. The heat loaded into the store during the summer is surplus heat from the gas-based public district heating system in Luleaa. Apart from circulation problems during the first operational year, the store has constituted a reliable part of the building heat system. Measurements have been made of the water flow rate through the store, hourly supply and return temperatures and rock temperatures measured once a day at 36 points in the body of the rock. These measurements cover the first five years of operation, from 1983 to 1988. Daily mean values of the measurements are available on diskette, which can be purchased at cost price by interested parties. The mean values over the four most recent years indicate a heat input to the store of 2266 MWh/year, with a mean abstraction over the same period of 993 MWh/year. Heat transfer in the boreholes is poorer than had been expected. This applies particularly during the abstraction periods. In the light of the experience that we now possess we can see that the geometry of the store should have been different. Total construction costs in 1982 could have been reduced by 13% as a result of one single change: drilling the store to a depth of 125 m instead of the present 65 m. This would have allowed the number of boreholes to be reduced to 64, from the present 120.

50913 (DTH-LET-RE-89-6) **Low temperature heat storage in aquifers.** Niemi Soerensen, S.; Boldt, J.; Qvale, B. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Energiteknik. Dec 1989. 125p. (In Danish). Order Number DE91707395. Source: NTIS (US Sales Only), PC A06/MF A01.

The aim of this pilot project was to investigate potentials for low temperature heat storage in ground water reservoirs using an already developed model for high temperature storage. Information has been drawn from a similiar project undertaken in China, and an actual demonstration system at Risoe National Laboratory (Denmark) was utilized. Conditions (including economic aspects) and the potential needs for using larger low temperature heat storage in connection with district heating plants in Denmark are described. An examination of the hydro-geological environment on which the choice of location depends was carried out. It was concluded that there are a considerable number of suitable Danish underground

localities suitable for the storage of heat in ground water reservoirs. The recovered thermal energy from industrial processes, for example, could be used for heating Danish households. This is possible because Danish consumers pay high prices for heat and electricity. Heat storage systems of this kind could be established almost anywhere in Denmark without any negative influence on domestic water supply. For industrial concerns it would not be advantageous to recover their surplus heat, but where it is possible for district heating plants to make use of it free of charge (by building a heat pump system and such heat storage facilities) payback should be possible within 5 years. In other countries than Denmark it has been proved possible to store and recover heat in natural ground water reservoirs and a temperature of under 60 deg. C without significant monetary loss. High temperature storage seems currently to be still at the experimental stage. (AB) 24 refs.

50914 (RISO-M–2852) **The Danish aquifer thermal-energy storage project: Demonstration plant. Operational experiences and results.** Energiministeriets Energiforskningsprogram. Varmelagering i grundvandsresevoir. Report, 1-5. Schleisner Ibsen, L.; Qvale, B.; Brejl, L. Risoe National Lab., Roskilde (Denmark). Jun 1990. 179p. Contract EM-22633;Contract EM-2263-411;Contract EM-1443/85-9. Order Number DE91707364. Source: NTIS (US Sales Only), PC A09/MF A01.

EFP-80; EFP-81; EFP-82; EFP-84; EFP-85.

A part of the Danish aquifer thermal-energy storage project consisted in construction and operation of a demonstration plant. The demonstration plant was established in Hoersholm north of Copenhagen in 1982. During the years of 1982-1987, altogether six charging processes have been carried out. Due to various difficulties for some year, the discharge (recovery) part of the storage cycle had to be omitted. In 1988 the demonstration plant was closed down. The project has been a collabortion between Risoe National Laboratory, the Laboratory for Energetics at the Technical University of Denmark and the Geological Survey of Denmark. In 1986 N and R Consult A/S and the owner of the incineration plant Nordforbraending I/S joined the project. At the same time the storage plant was taken over by Nordforbraending I/S. The project has been financed by the Danish Ministry of Energy's energy research programs EM-2, EFP-81, EFP-82 (EM.J.No. 22633), EFP-84 (EM-J.No. 2263-411) and EFP-85 (EM-J.No. 1443/85-9). During 1986-1988 the project was partly financed by "new technologies" under the Danish Ministry of Energy. The present report describes the experiences gained and results of the six storage-recovery cycles which have been carried out during the project. (author) 8 tabs., 53 ills., 8 refs.

50915 Relationship of regional water quality to aquifer thermal energy storage. Allen, R.D. (Pacific Northwest Lab., Richland, WA (US)); Raymond, J.R. pp. 415-436 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper assesses ground-water quality and associated geologic characteristics as they may affect the feasibility of aquifer thermal energy storage (ATES) system development in any hydrologic regions. It was determined that seven physical and chemical mechanisms may decrease system efficiency. Factors affecting ground-water chemistry are explained.

2508 Chemical

Refer also to citation(s) 50727

2509 Batteries

Refer also to citation(s) 51122, 51146, 51349, 51627

50916 (CONF-9006243–2) **Development of high performance sodium/metal chloride cells.** Vissers, D.R.; Bloom, I.D.; Hash, M.C.; Redey, L.; Hammer, C.L.; Dees, D.W.; Nelson, P.A. Argonne National Lab., IL (USA). [1990]. 31p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 8. beta battery workshop; Chester (UK); 12-18 Jun 1990. Order Number DE90017668. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sodium/metal chloride (MCl_2) cells and batteries are being studied at Argonne National Laboratory (ANL) for stationary energy storage and transportation applications. The work is being directed toward (1) development of thin, high-capacity density electrodes and inexpensive β''-alumina-glass composite electrolyte materials to replace β''-alumina and (2) the development of models to project MCl_2 system performances. In our $NiCl_2$ electrode work, the effects of charge/discharge rates, temperature, electrode porosity, and sulfur content on electrode performance were determined using annular electrodes fabricated in the uncharged state. Of all electrode design parameters mentioned, electrode porosity, sulfur content, and charge rates have the greatest effect on utilization and on the area-specific impedance. The β''-alumina-glass composite electrolyte work has led to the development of a highly conductive (3.3×10^{-2}S/cm at 250°C) composite material. Preliminary modeling studies indicate that the performance of the MCl_2 electrodes can be fitted by a mathematic model very successfully and that cell electrolyte configurations of either multiple tubes joined at a header or compartmented flat structures of either β''-alumina or of the composite material would result in high-performance batteries with power-to-energy ratios of about 5. 15 refs., 8 figs., 4 tabs.

50917 Electrochemical investigations of a class of novel solid redox cathodes. Lium, M. (Lawrence Berkeley Lab., CA (USA). Materials and Chemical Sciences Div.); Visco, S.J.; DeJonghe, L.C. pp. 96-97 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC03-76SF00098. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The electrochemical properties of a class of novel solid redox cathodes have been characterized using various techniques. Experimental observations have shown these materials to be excellent candidates for all-solid state thin-film energy-storage systems. Some of the advantages offered by the batteries based on these solid cathodes include high energy density and rate capability, extensive utilization of cathode capacity, easy of fabrication, low cost, and superior reliability and safety. Furthermore, these materials are reversible to lithium and sodium (as well as many alkaline earth and transition metals), allowing for a much greater choice of anodes in comparison to cells based on analogous intercalation compounds.

50918 All-solid state thin-film rechargeable lithium batteries with novel solid redox cathodes. Liu, M. (Lawrence Berkeley Lab., CA (USA). Materials and Chemical Sciences Div.); Visco, S.J.; DeJonghe, L.C. pp. 94-95 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC03-76SF00098. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

All-solid-state energy-storage systems have attracted worldwide attention and are currently being pursued by a number of battery developers. To date, the majority of cathode materials used in these systems have been intercalation compounds with $LiTiS_2$ cells demonstrating the highest levels of performance. Although these batteries have many advantages over similar lithium cells involving liquid electrolytes, their limited rate capability and low utilization of cathode capacity has hindered their practical application. Recent investigations in this laboratory on alternative cathode materials have indicated that the rate capability of solid-state lithium batteries can be substantially improved by replacing the costly intercalation materials with inexpensive novel cathodes which having much faster mass transport and electrode kinetics. A number of lithium cells having solid redox polymerization electrodes (SRPE) have been constructed and characterized from ambient to 100°C at various current densities. Early results are discussed.

50919 Ambient temperature high-rate lithium/organosulfur batteries. Visco, S.J. (Lawrence Berkeley Lab., CA (USA). Materials and Chemical Sciences Div.); Liu, M.; DeJonghe, L.C. pp. 87-88 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA)

(1990). pp. 1010 DOE Contract AC03-76SF00098. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Lithium electrodes have attracted considerable attention for ambient, medium, and high temperature battery systems due to their high electropositive potential, low equivalent weight, and tendency to passivate in a variety of non-aqueous catholytes. Investigations in the authors laboratory on sodium β''-alumia/organosulfur batteries led to the study of ambient temperature lithium/organosulfur systems. Organosulfur positive electrodes are based on the reversible redox dimerization reaction, $2e'' = 2\ RS''$, where R is an organic moiety such as CH_3 $(C_2H_5)_2NC$ = $S,CH_3CH_2OCH_2CH_2$, etc. A Li/RSSR cell would therefore have the general cell reaction, 2 Li + RSSR = 2 LiSR, in which case the lithium thiolate salt might either be soluble in the liquid disulfide, or soluble in a solvent included in the positive electrode formulation. Theoretical energy densities of Li/RSSR cells typically range form 400 to 1400 Whr/kg depending on the R group. The authors present results which outline the behavior of one of many possible Li/RSSR cells, the lithium/(tetraethyl thiuram disulfide) battery.

50920 The nickel oxide electrode: Structure and performance. McBreen, J. (Materials Science Div., Dept. of Applied Science, Brookhaven National Lab., Upton, NY (US)). pp. 25 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC02-76CH00016. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

This paper reports how the nickel oxide electrode reaction proceeds via a reaction with solid reactants and products. Furthermore, there are no soluble intermediates. Elucidation of every aspect of the reaction has been difficult. Items which are normally considered trivial such as determination of the reversible potential, have required much effort and ingenuity.

50921 Effect of electrolyte composition on zinc plating in zinc-bromine battery electrolytes. Petersen, R. (Corp. Applied Research, Johnson Controls Inc., Milwaukee, WI (US)); Yin, M.P. pp. 16-17 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The zinc/bromine battery is an attractive high performance, low cost battery system which is presently being developed for both electric vehicle and load management applications. Potentially, the cycle-life of a zinc/bromine battery need only be limited by the long term chemical stability of its plastic based material components. However, under certain conditions, needle-like, dendritic deposits can form on the zinc electrodes of the battery, resulting in cell shorting and premature cycle-life failure. The authors have carried out experiments to identify those battery operating conditions, electrolyte compositions and plating electrode deposits, thus helping to assure maximum cycle-life for the zinc/bromine battery. This paper concentrates mainly on the effects of electrolyte composition on zinc plating morphology in zinc/bromine battery electrolytes. The authors discuss how electrolyte conductivity additives can influence zinc plating behavior.

50922 EXAFS studies of zincate complexes in alkaline electrolyte. McBreen, J. (Materials Science Div., Brookhaven National Lab., Upton, NY (US)); O'Grady, W.E.; Tourillon, G.; Dartyge, E.; Fontaine, A.; Pandya, K.I. pp. 12 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AS05-80ER10742 ;AC02-76CH00016. Grant 86/532. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The coordination chemistry of Zn^{++} in alkaline electrolyte has been studied for over sixty years. In the past thirty years several spectroscopic studies were made. Most investigators conclude that only $Zn(OH)_4$ are present. However, other species such as $[Zn(OH)_4.2H_2O]$ = have been proposed. Potentiometric studies always involve assumptions about the activities of various components. The application of various scattering and absorption spectroscopies to electrolyte studies has been critically reviewed. This points out the difficulty in studying hydrated ions. This paper discusses how in the past decade considerable progress has been made, using EXAFS to study the structure of complexed ions.

50923 Improved cycle-life performance with alkaline-carbonate electrolytes in Zn/NiOOH cells. pp. 7-8 of Electrochemical Society 1989. Fall meeting (Abstracts): Volume 89-2. Adlev, T.C.; McLavnon, F.R.; Cairns, E.J. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Redistribution of active material (shape change) in the zinc electrode seriously degrades the cycle-life performance of Zn/NiOOH cells. It is well known that shape change can be retarded by reducing the zincate-ion concentration in the electrolyte. Because ZnO solubility depends strongly on the hydroxyl-ion concentration, substitution of various anions for hydroxyl ions in the electrolyte lowers zincate-ion solubility while maintaining acceptable conductivity. A previous study successfully applied this strategy using fluoride and borate anions. The authors report the results of an evaluation of alkaline-carbonate electrolytes in small test cells.

50924 Advances in sodium sulphur cell safety. Stackpool, F.M. (Chloride Silent Power Ltd., Runcorn, Cheshire (GB)). pp. 149-150 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The paper reports on the development of a small 10 Ah, central sodium cell (code Mark 3) which is both reliable and robust; characteristics which make it eminently suitable for motive power applications. Employing a multiplicity of small cells an appropriate cell interconnection network and cell redundancy have enabled CSPL to follow a maintenance-free approach to battery design. A further advantage of this approach is that the multi-partitioning of small quantities of reactive materials enhances battery safety in the event of cell failure or mechanical damage to the battery. Improvements in battery safety have been made with the introduction of cell safety features (cell code MK3SF) which have been developed using a proven cell safety strategy, and which provide the desired safety characteristics whilst maintaining a high cell energy density.

50925 Effect of some design parameters on the performance of $NiCl_2$ electrodes. Bloom, I. (Argonne National Lab., IL (USA). Chemical Technology Div.); Orth, S.K.; Vissers, D.R. pp. 145-146 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-31-109-ENG-38. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Performance tests were completed with initially uncharged, annular $NiCl_2$ electrodes. These tests were undertaken to determine the effect of various design parameters, such as electrode thickness (1.5-3.0 mn), electrolyte volume fraction, Ni particle size, and loading density, on the performance of NiCl, electrodes in the cell $Na||\beta''$-alumina$||NaAlCl_4|NiCl_2$(2 wt % sulfur in the nickel chloride electrode). All cells were cycled at 260°C between about 2.1 V and 2.85 V. In a typical voltage versus time profile, the cells had two discharge plateaus, corresponding to the EMFs of 2.59 and 2.13 V.

50926 Investigations of $Ni/NiCl_2$ electrodes in basic chloroaluminate melt. Redey, L. (Argonne National Lab., IL (USA). Chemical Technology Div.); Vissers, D.R. pp. 143-144 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-31-109-ENG-38. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Sodium/metal chloride cells represent a new class of advanced battery cell systems. Two versions of the positive electrodes, Fe/$FeCl_2$, are under investigation. The experiments described were designed to study the electrochemical properties of the $Ni/NiCl_2$ electrode in chloraluminate melt. The objective was to gain a better understanding of the charge-discharge mechanism and the effect of various parameters on the performance of this electrode.

50927 Progress in sealing Li-alloy/FeS_2 cells for a bipolar battery. Kaun, T.D. (Argonne National Lab., IL (USA). Chemical Technology Div.); Gillie, K.R.; Duoba, M.J.; Smaga, J.A. pp. 111-112 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

This paper reports how progress in the development of Li-alloy metal disulfide cells has resulted in high performance with long cycle life (>1000 cycles). Battery development has been further advanced by the recent achievement of the overcharge tolerance feature for the molten-electrolyte cells (375-475°C operating temperature). A desire to enhance battery specific power and energy, while reducing cost (by limiting the use of molybdenum), has led to our initiation of development work on a sealed bipolar battery. A bipolar Li-alloy/FeS_2 battery has outstanding prospects for achieving high performance. Batteries of greater than 200 Wh/kg and 500 W/kg are possible. The current collector (or bipolar plate) can be as simple as a sheet; therefore, the low-cost approach of employing coated (e.g. TiN or Mo) steel or molybdenum components is feasible. Electrolyte containment is a major challenge for bipolar battery development The authors discuss their design approach, in which each cell in the bipolar stack is hermetically sealed.

50928 Novel high-rate, solid-state lithium batteries and their relationship to protein folding. Visco, S.J. (Lawrence Berkeley Lab., CA (USA). Materials and Chemical Sciences Div.); Liu, M.; Armand, M.B.; DeJonghe, L.C. pp. 103 of Electrochemical Society 1989. Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC03-76SF00098. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The solid-redox-polymerization electrodes (SRPEs) have been shown to have high thermal and chemical stabilities, as well as fast mass transport and electrode kinetics. One battery based on these materials, a Li/PEO/SRPE cell, has achieved over 75 cycles (still cycling), at a sustained power density of 150 W/kg (144 W/l), and a sustained energy density of 260 Wh/kg with little evidence of deterioration of performance at 77 to 80°C. At 100°C, the Li/PEO/SRPE cell demonstrated a complete discharge cycle (100% of available capacity) at a current density of 10 mA/cm^2 (12 c rate) and a power density of 2400 W/kg. At ambient temperature, the Li/PEO/SRPE cells could be discharged at current densities of over 250 μA/cm^2. This paper discusses how the properties of this novel redox system are most clearly illustrated by comparison to the mechanism of protein folding. The SRPE materials can be generated as 1,2, or 3-dimensional networks, depending on the mechanical, and electrochemical properties desired. Efforts are currently underway to synthesize a 2-dimensional ladder polymer which will unfold upon discharge of the Li/PEO/SRPE cell.

50929 Rechargeable molten-electrolite lithium batteries: A status report. Kaun, F.D. (Argonne National Lab., IL (USA). Chemical Technology Div.). pp. 108-109 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-31109-ENG-38. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Continuing development of rechargeable Li-alloy/metal sulfide batteries has an objective of improving performance and cycle life, as well as the substitution or application of low-cost materials. This has required changes in the cell electrochemistry. For example, only in recent years has an electrolyte been identified which supports long cycle and high performance for the upper-plateau (U.P.) FeS_2 version $FeS_2 + 2Li \rightarrow 2Li_2FeS_2$. In addition, new overcharge tolerant cells can provide built-in charge equalization for cells in a battery and increase cycle life. Two cell types dominate the research and development efforts: LiAlSi/FeS (1.32 volts) with LiF-LiCl-LiBr (22:31:47 Mol%) operated at 475°C and LiAl/U.P.FeS_2 (1.75 volts) with LiCl-LiBr-KBr (25:37:38 mol%) FeS_2 electrode has traditionally required a molybdenum current collector (substitute materials are being developed), while the FeS battery development has proceeded with Fe or Ni current collectors. The cell specific energy and power of about 200 Wh/kg and 200 W/kg, or about double that of the FeS-type cells. In this paper, the development status of these two cell systems is examined.

50930 The nature of iron passivation studied by optical second harmonic generation and ac polarography. Schauer, M.W. (North Carolina Univ., Chapel Hill, NC (USA)); Frye, J.M.; Pellin, M.J.; Gruen, D.M. pp. 873 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

As a polycrystalline iron electrode is scanned anodically in basic solution, an oxide film forms which inhibits further oxidation. The nature of this passive film has been extensively studied for the past 150 years. One model, based on AC impedance and ellipsometry measurements describes the film as a Chemi-conductor or redox conductor, where the conductivity through the film occurs by electron hopping between redox centers. This conductivity is limited by the slow diffusion of counter ions through the film. This hindered mobility of ions through the film leads to concentration gradients of ions and redox species in the direction perpendicular to the electrode surface. These concentration gradients change as the potential is scanned, and gives rise to the complicated potential dependence of the AC measurements. This paper discusses how the intensity of optical second harmonic generation (SHG) from an electrode surface is affected by several properties of the system. The nonresonant intensity is material and environment dependent, and for some systems is ultra-high vacuum, has been correlated with the density of free electrons at the surface. If some species at the interface exhibits electronic resonances at either the fundamental, or the second harmonic frequency, SHG from the interface will be enhanced.

50931 Infrared spectroscopic determination of pH changes in diffusionally decoupled thin layer electrochemical cells. Bae, I.T. (Case Western Reserve Univ., Cleveland, OH (USA). Dept. of Chemistry); Scherson, D.; Yeager, E. pp. 966-967 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

In-situ reflection absorption infrared spectroscopy has provided much insight into a variety of interfacial process, including adsorbatesubstrate interaction and their dependence on potential interactions and their dependence on potential, as well as the mechanism of a growing number of electrode reactions. The in-situ Fourier transform reflection absorption spectroscopy FTIRRAS experiments described show that a semi-quantitative measure of the local pH in the thin electrolyte layer can be obtained by incorporating judiciously chosen IR active species in the solution. Based on this approach it has been possible to determine that depending on the magnitude of the current and the solution composition, the local pH can differ by several units from that in the bulk reservoir. In addition, FTIRRAS results are presented for the oxidation of CO on polycrystalline Pt in 0.1 M NaOH, from which important information has been obtained regarding the reaction mechanism.

50932 Recent advances in high-speed dc relaxation measurements. Nagy, Z. (Argonne National Lab., IL (USA). Materials Science and Technology Div.). pp. 928-929 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-31-109-ENG-38. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The dc relaxation techniques are commonly used for the study of kinetics of fast electrode reactions. The basic principle of the technique is simple: the electrode system, which is kept initially at equilibrium or is some known steady state, is suddenly perturbed by a nonrepetitive electrical excitation, and the relaxation of the system back to equilibrium or to some new steady state is observed. Because the elementary steps of the reactions usually respond at different rates to the excitation, the characteristics of the individual elementary steps can be determined. The most commonly used dc relaxation techniques are the galvanostatic (current step), potentiostatic (potential step), and coulostatic (charge step) techniques.

50933 Studies of the kinetics of electron or ion transfer using an indirect laser-induced interfacial temperature-jump method. Smalley, J.F. (Brookhaven National Lab., Upton, NY (USA). Applied Science Dept.); Geng, L.; Feldberg, S.W. pp. 925 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC02-76CH00016. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The indirect laser-induced interfacial temperature jump (ILIT) method has been elucidated in previous publications. The laser pulse impinges on the back, non-electrolyte, surface of a thin foil (or film) electrode. Indirect heating, distinguishes this approach from the direct (pulsed laser) heating where the light impinges upon the electrode/electrolyte interfaces. The change in interfacial temperature described by a virtually exact solution of the appropriate heat transport equation is coupled to the various electrochemical phenomena that can effect a change in open-circuit potential. A master differential equation describes the open-circuit response for a variety of electron concomitant concentration polarization is included. The solution to the equation is obtained by standard Laplace transform techniques.

50934 A nickel/hydrogen battery for PV systems. Bush, D.M. (Sandia National Labs., Albuquerque, NM (USA)). *IEEE Aerospace and Electronic Systems Magazine (USA),* 5(8): 27-30 (Aug 1990).

The nickel/hydrogen battery was developed in the early nineteen-seventies as an energy storage subsystem for commercial communication satellites. The advantages offered by nickel/hydrogen batteries, including long life, low maintenance and high reliability, make it very attractive for terrestrial applications such as stand-alone photovoltaic systems. The major drawback to the wider use of the nickel/hydrogen battery is its high initial cost. Sandia National Laboratories has placed cost-shared contracts to reduce the cost, and a battery consisting of prismatic cells in a common pressure vessel has evolved. This paper describes a 7-kWh battery which has been on test at Sandia since January 1988 using a flat-plate photovoltaic array for charging.

2510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 50934

29 ENERGY PLANNING AND POLICY

Refer also to citation(s) 51642

50935 (QMER–E20) **Energy, the driving force of economic development: An energy policy for the 1990s.** Quebec Ministere de l'Energie et des Ressources, Quebec, PQ (Canada). 1988. 127p. (MICROLOG–90-03902). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Quebec's energy policy for the 1990s and its impact on economic development are described. The energy assets of Quebec, including hydroelectrical power, are summarized. The objectives of Quebec's energy policy are: to stimulate economic and regional development; to maximize the industrial fall-out of energy activities (including technology transfer and research); to maximize the utilization of Quebec's hydroelectric resources; to guarantee the safety of energy supplies and Quebec's access to Canadian resources; to encourage competition in the energy sector, for the benefit of consumers; to better utilize existing energy sources and to develop new ones; and to protect the quality of the environment and social life. The topics of electric power, natural gas, petroleum and petro-chemistry, energy efficiency, research and development, and the environment and social life are discussed. The role of the Quebec government is explained. An Energy Institute, common to French-speaking countries, will be established in Quebec City in 1988. In conclusion, although the government has very powerful means of intervention, the choice of an energy policy should rely on the collaboration of all the participants in the energy sector, including the public. 47 refs.

2901 Energy Analysis and Modeling

Refer also to citation(s) 50776, 51067, 51081

50936 (CONF-900801–30) **Energy models and national energy policy.** Bloyd, C.N.; Streets, D.G.; Fisher, R.E. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90017682. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As work begins on the development of a new National Energy Strategy (NES), the role of energy models is becoming increasingly important. Such models are needed to determine and assess both the short- and long-term effects of new policy initiatives on US energy supply and demand. A central purpose of the model is to translate overall energy strategy goals into policy options while identifying potential costs and environmental benefits. This paper will first describe three models currently being utilized in the NES process, followed by a detailed listing of the publicly identified NES goals. These goals will then be viewed in light of the basic modeling scenarios that have been proposed as part of the NES development process. 4 tabs.

50937 (CONF-9005272–1) **Evaluating the environmental impacts of the energy system: The ENPEP [ENergy and Power Evaluation Program] approach.** Hamilton, B.P.; Sapinski, P.F.; Cirillo, R.R.; Buehring, W.A. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. DOE Assistant Secretary for International Affairs and Energy Emergencies; U.S. DOE Nuclear Energy; International Atomic Energy Agency. DOE Contract W-31109-ENG-38. From IAEA (International Atomic Energy Agency) advisory group meeting on experience with using the agency's model WASP for energy and nuclear power planning in developing countries; Vienna (Austria); 21-25 May 1990. Order Number DE90017862. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Argonne National Laboratory (ANL) has developed the ENergy and Power Evaluation Program (ENPEP), a PC-based energy planning package intended for energy/environmental analysis in developing countries. The IMPACTS module of ENPEP examines environmental implications of overall energy and electricity supply strategies that can be developed with other ENPEP modules, including ELECTRIC, the International Atomic Energy Agency's Wien Automatic System Planning Package (WASP-III). The paper presents the status and characteristics of a new IMPACTS module that is now under development at ANL. 3 figs.

2902 Economics and Sociology

Refer also to citation(s) 50331, 50467, 50493, 50569, 50954, 51008, 51016, 51019, 51020, 51067

50938 (AEK–90-03-03(0)) **The psycho-sociological impact of a large technological development on a rural area with specific reference to the Mossel Bay area.** Waal, H.S. de. Atomic Energy Corp. of South Africa (Pty) Ltd., Pretoria (South Africa). May 1989. 454p. (In Afrikaans). Order Number DE91604367. Source: NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

An adaption of a classified report, presented as a thesis for the degree D.Phil. in Sociology, University of Pretoria, South Africa.

The public acceptability of large technological developments was studied. A socio-economic baseline profile of the community was compiled in an attempt to measure the inherent ability of a community to adjust to changes brought about by large developments. The framework within which the study was conducted included the demographic composition, the economic activity, the infrastructure of the private and public sectors, the organisational composition of the community, the expectations members of the community had in respect of the possible developments, the attitudes of the community towards itself, as well as towards outsiders and finally, the degree of solidarity that exists amongst them in respect of these

attitudes. With information regarding the intended developments, certain extrapolations were made in respect of possible tendencies and changes that may come about in the demographic composition of the community. In the light of these predictions certain potential future problems were identified and pre-emptive recommendations were made accordingly. Of the most important observations that can be made is the fact that the methods used were adequate to achieve a detailed baseline profile of the community, its qualities, attitudes and expectations. The detail was sufficient to enable the researcher to compare the communities living in the different residential areas. Information gathered from interviews with leading figures turned out to be a useful tool in the verification of data gathered by way of questionnaires. 71 figs., 110 tabs., 176 refs.

50939 (CONF-901191–1) **Improving risk communication through interactive training in communication skills.** White, D.A.; White, R.K. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 11. annual national conference and exhibition of the Hazardous Materials Control Research Institute: superfund '90; Washington, DC (USA); 26-28 Nov 1990. Order Number DE91000624. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a workshop in communication and public speaking skills recently conducted for a group of public officials whose responsibilities include presenting risk information at public meetings associated with hazardous waste sites. We detail the development and execution of the 2 1/2 day workshop, including the development and integration of a 45-minute video of a simulated public meeting used to illustrate examples of good and bad communication behaviors. The workshop uses a mock public meeting video, participatory video exercises, role-playing, and instructor, and a resource text. This interactive approach to teaching communication skills can help sensitize scientists to the public's understanding of risk and improve scientists' confidence and effectiveness in communicating scientific information. 10 refs., 1 fig.

50940 (Juel-Spez–524) **Listing the investment costs and producing material analyses for given plants for energy supply.** Angewandte Systemanalyse. Wagner, H.J.; Hansen, K.; Schoen, R.; Wassmann, B. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung; EST Gesellschaft fuer Energiesystemtechnik mbH, Essen (Germany, F.R.). Oct 1989. 117p. (In German). Order Number DE91706102. Source: NTIS (US Sales Only), PC A06/MF A01.

In this comparison, the investment and material cost for the following plants are examined: 1. Solar service water treatment plants, 2. Solar heating plants, 3. Conventional comparative plants, 4. Heat pump heating plants, 5. Nuclear power stations and hardcoal-fired power stations, and 6. Wind energy converters. The technique of energy conversion of each is generally explained. In the appendix, points of the use of energy are given for the manufacture of components of the heating and installation trade. Specific energy costs per product unit are compiled for the different branches. (UA).

50941 (LA-UR–90-3182) **Working with 36 CFR Part 79: Experience at Los Alamos National Laboratory.** McGehee, E.D. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-7405-ENG-36. (CONF-9004247–1: American Society for Conservation Archaeology conference, Las Vegas, NV (USA), Apr 1990). Order Number DE91000368. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In anticipation of the new federal curation regulation, staff at Los Alamos National Laboratory (LANL) have begun a curation program which complies with the proposed law. Cultural resources include archaeological sites dating from Archaic to Classic Period Anasazi as well as historical Homesteading and WWII (Manhattan Project) era sites. Recent curation work has included the identification of Department of Energy (DOE) owned archaeological and historical artifact collections and inspections of their various repositories have also been started. During the winter of 1989 all human skeletal remains excavated from DOE/LANL land (from 1943 to present) were located and inventoried. At present, all such sensitive materials are curated with the Museum of New Mexico and the Maxwell Museum of Anthropology's Osteology Laboratory at the University of New Mexico. This paper discusses problems and issues that have arisen for the LANL curation program. These include artifact ownership, inadequate archival records, repository acquisition of federally-owned collections, evaluation of repositories, evaluation of artifact condition and curation plans for the future.

50942 (ML–4231) **The impact of acidification on the economic value of recreational fishing in eastern Canada.** Economic and commercial analysis report, No. 14. Michaud, L. Michaud (L.), Inc., Montreal, PQ (Canada). Mar 1989. 140p. Contract FO FP802-8-2598-01-SS. (MICROLOG–90-03223). Source: PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper considers the economic impact of acidification in Eastern Canada. It attempts to predict the implications related to different acidification scenarios. In total, five hypothetical scenarios are evaluated using the travel cost method. If there had been no acidification, present demand would be 68.6 million fishing days annually rather than 55 million. The loss incurred since the onset of acidification is $553 million (1988 $) per year. If the acidification level was to be maintained, 14.4 million additional fishing days would be lost each year, representing $4.4 billion of net loss over the next 50 years relative to 1988. If Canada were to reduce its own air emissions the net loss would be reduce to 9.1 million fishing days for a total impact of $2.9 billion over 50 years. If Canada and the United States joined their efforts to reduce 42% of acid emissions affecting our regions, the losses would be limited to 4.6 million fishing days corresponding to a net economic loss of $1.5 billion over 50 years. Finally, a pessimistic scenario which considers an increase of 10% in acid emissions would cause a reduction of 16 million fishing days. The equivalent net economic loss would be $4.8 billion over 50 years. This paper demonstrates the magnitude and importance of the impact of acidification on the Canadian economy, related to recreational fishing. 23 refs., 15 figs., 28 tabs.

50943 (OE/RT–90-03626-Vol.1, pp. 36-48, Paper E12) **Economic evaluation of global warming policies.** Dewees, D.N. (Univ. of Toronto, Toronto, ON (Canada)). Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper discusses some of the contributors to global warming, reviews existing environmental policies, identifies proposals for dealing with the global pollutants, and evaluates policies that are likely to have a substantial impact on those problems. Carbon dioxide, methane, chlorofluorocarbons (CFC), ozone and water vapour are the gases responsible for global warming, with carbon dioxide being the major contributor. Traditional environmental policies were designed to deal with local pollution concentrations, not global pollution problems. While the Environmental Protection Agency's (EPA) action under the Montreal Protocol may be a step toward satisfactory CFC control policy, there has been no action on carbon dioxide. Actions that might be adopted to reduce greenhouse gas emissions include: improving new automobile fuel economy; reducing automotive emissions; improving home insulation and home heating efficiency; eliminating net global deforestation; phasing out CFCs; imposing carbon emission fees and or production fees on coal, oil, and natural gas; pursuing research and development on alternative fuels and solar technology; promoting mass transit; and abandoning subsidies to energy and resource industries. To reduce carbon dioxide emissions substantially, it will be necessary to set limits on total emissions by isssuing emission rights, or to impose a charge for those emissions. A second element in a policy to reduce CO_2 emissions is an end to subsidies for fossil fuel productions.

These policies will have a significant impact on energy consumption and some effect on trade in energy resources. 12 refs., 3 tabs.

50944 (STEV–1989-R9) **Images of the future world around us seen from the aspect of energy policy.** Block, E. Statens Energiverk, Stockholm (Sweden). Dec 1989. 111p. (In Swedish). Order Number DE91707845. Source: NTIS (US Sales Only), PC A06/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

This report, written by a futurologist, treats different scenarios for changes in political, economical and demographical development pertaining to energy-related activities. (U.W.).

50945 (STEV–1989-R10) **Means to reduce CO_2-emission under Swedish 'control'.** Bohm, P. (Stockholm Univ. (SE). Dept. of Economics). Statens Energiverk, Stockholm (Sweden). Dec 1989. 23p. (In Swedish). Order Number DE91707847. Source: NTIS (US Sales Only), PC A03/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

Reduction of the emission of carbon dioxide is paramount in the efforts to mitigate the greenhouse effect. In this report the author advocates views on international repercussions as an answer to unilateral actions taken by Sweden. Economical as well as non-economical incentives are discussed. The problem of possible migration of Swedish pollutant-intensive industries and the need for multilateral agreements are also considered. (U.W.).

50946 (STEV–1989-R16) **Energy, authority and the future.** Tengstroem, E.; Haard, M.; Berner, B.; Edqvist, C.; Kaijser, A. Statens Energiverk, Stockholm (Sweden). Dec 1989. 126p. (In Swedish). Order Number DE91707857. Source: NTIS (US Sales Only), PC A07/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The starting point for this report is that the problems of future energy supply and energy utilization in Sweden, cannot be solved solely with technical methods. The pure technical solutions must always be combined with broader societal, economical and political measures. Outgoing from this concept five authors have written historical and futurological chapters. 1. Utopia and reality in energy future: A glimpse backwards. 2. Technology - a creation of society. 3. Knowledge for change - about dynamic and inertia in socio-technological systems. 4. Technological change and technology policy. 5. The growth and future of the Swedish power production system. (U.W.).

50947 (UCL-DE-DP–89-09) **Non-linear prices and energy demand.** Markandya, A.; Pemberton, M. University Coll., London (UK). Dept. of Economics. Jan 1989. 19p. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This paper examines the use of non-linear price structures in the context of the demand for energy. Such structures are attractive because they permit policy makers to meet the objective of equity without sacrificing that of resource mobilisation and economic efficiency. The paper concentrates on two aspects of this issue. The first is the accurate forecasting of demand in the presence of such price structures and the second is the design of the optimal non-linear tariff given some suitable welfare loss-minimising criterion. In addition to looking at the theoretical aspects of the problem, the paper also has some illustrative results on forecasting demand with non-linear electricity tariffs in Pakistan. (author).

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Refer also to citation(s) 50331, 50336, 50373, 50618, 50637, 50673, 50936, 50939, 50942, 50943, 50989, 50991, 51004, 51005, 51016, 51644, 51670, 51672, 51688, 51707, 51708, 51709, 51710, 51758, 51879

50948 (CONF-9008153–1) **Democratic theory, science, and decision making in global climate change: Culpability, uncertainty, and fairness.** Feldman, D.L. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Political science association annual meeting on global climate problems and public policy; San Francisco, CA (USA); 29 Aug - 2 sep 1990. Order Number DE90017316. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Uncertainty over the causes and consequences of global climate change poses three challenges to policy makers: (1) countries may become divided into "winners" and "losers" as a result of the distribution of positive and negative impacts from global warming: (2) climate change beneficiaries may be jeopardized by covetous losers; and (3) the costs of climate change will be borne by future generations. This paper contends that durable responses to climate change will be difficult to formulate because any policy can be criticized as empirically deficient, and thus, a hasty response which is likely to hurt economic growth. Three paths for ethically appropriate policies are suggested: (1) policy makers should develop rules for allocating benefits and costs of climate-related activities which are not dependent on preserving existing economic and political structures. These structures mask inequities between developed and developing countries. (2) Science has a limited capacity for establishing consensus over the impacts of, or solutions to, climate change. Thus, novel means of incorporating public preferences in the search for durable policy are required. (3) The impacts of climate change are unclear. Thus, any response is likely to be fallible and should be designed to be adjustable and negotiable. This "reasonable fallibility" approach emphasizes limited confidence in our ability to effect positive or negative changes to nature. 40 refs.

50949 (EC–90-03115) **Environmental Advisory Committee on Newfoundland and Labrador Marine Transportation, 1984-1989. Response to recommendation No. 80, Beaufort Sea Environmental Assessment and Review Panel: Final report.** Environment Canada, Ottawa, ON (Canada). Sep 1989. 74p. (MICROLOG–90-03115). Source: PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Environmental Advisory Committee on Newfoundland and Labrador Marine Transportation (EACNLMT) met on seven occasions within the province between 1984 and 1989 and provided a forum for the public, industry, and provincial and federal governments to discuss their concerns and exchange information related to shipping activities in the Labrador Sea and Strait of Belle Isle. To enhance its understanding of certain issues, the Committee invited spokespersons for various interests to address its members during meetings. Industry representatives outlined specifics regarding the Bent Horn project and plans for the transport of oil and gas through east coast waters with attention to tanker design and routes and anticipated impacts. Canadian Coast Guard (CCG) representatives described their plans for upgrading and consolidating the telecommunications network and presentations on ice information capabilities and the potential impacts of oil and marine traffic on the seabird resource were made by Environment Canada personnnel. Through its deliberations, the Committee was able to successfully address its most important tasks of: identifying environmental and socio-economic issues associated with shipping oil and gas through the Labrador Sea and Strait of Belle isle; reviewing shipping activities south of 60°N and highlighting potential impacts associated with this vessel traffic; examining the legal and administrative regime for marine waters north and south of 60°N; and, identifying and priorizing research needs. 51 refs.

50950 (EPRI-NP–6989) **Survey of earthquake-induced fires in electric power and industrial facilities: Final report.** Swan, S.W. (EQE Engineering, Inc., San Francisco, CA (USA)); Harris, S.P. Electric Power Research Inst., Palo Alto, CA (USA); EQE Engineering, Inc., San Francisco, CA (USA). ©Sep 1990. 22p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Fires following earthquakes are a dramatic image, largely due to the destruction of much of the city of San Francisco by fire following the great earthquake of 1906. This report addresses the incidence of earthquake-induced fires, specifically in power and industrial facilities. Industrial and power facilities (including nuclear) share similar types of building construction and internal installations. More

importantly, they share similar potential sources of ignition, such as electric power cable and bus bars, gas lines, furnaces, boilers, and water sources located in proximity to electrical equipment. 22 refs.

50951 (FEARO–106-14/1989) **An evaluation of the Beaufort Sea Assessment Panel review.** Sadler, B. Federal Environmental Assessment Review Office, Ottawa, ON (Canada). 1990. 184p. (MICROLOG–90-03924). Source: PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

An environmental assessment was begun in 1980 to consider the environmental and socioeconomic implications of a multicomponent proposal for hydrocarbon production and transportation from the Beaufort Sea-Mackenzie Delta region. This assessment represented a significant expansion in the use of the environmental assessment review process by the federal government for planning management of northern development. For this reason, an evaluation of the experience was commissioned to examine the policy and institutional implications of the mandate of the Beaufort Sea review; to analyze the operational effectiveness of review procedures, especially those that represent departures from conventional practice; and to consider the contribution of the Panel's report to environment and development decision-making. The report examines the study strategy and research design, analyzes the role, practice, and impact of the Beaufort Sea panel review, and presents recommendations on process development, public involvement, accountability, and methods of learning from experience.

50952 (FFU-rep–88-3) **Environmental coverage in statistical yearbooks. An international comparison.** Lamm, J.; Schneller, M. Freie Univ. Berlin (Germany, F.R.). Forschungsstelle fuer Umweltpolitik. Feb 1988. 25p. (In German). Source: Available from Freie Univ. Berlin (Germany, F.R.). Forschungsstelle fuer Umweltpolitik.

The coverage given by statistical yearbooks to the environment permits no inference to the environmental policy of the country concerned. In Poland, for instance, the detailed and comprehensive environmental statistics of the yearbook are clearly in contrast to the obviously inadequate environmental policy prevailing. But one conclusion can safely be drawn from this investigation: The change of paradigms in recording the social reality of an industrialized country takes place in official statistical records with a long time-lag. The national balance-sheet of achievements still is predominantly a balance-sheet of economic achievement. In the categorial structure of overall national recording of reality, the ecological reverse of the medal still largely represents a no-man's-land. (orig./HSCH).

50953 (GSF-BPT–1/90) **Analysis of methodical approaches to the assessment and aggregation of information related to environmental impact assessments. Final report.** Rauschelbach, B. (Dornier System GmbH, Friedrichshafen (Germany, F.R.). Planungsberatung); Grueger, C.; Grueger, J.; Hanke, H.; Schemel, H.J. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen (GSF), Neuherberg (Germany, F.R.). Projekttraeger Umwelt- und Klimaforschung; Dornier System GmbH, Friedrichshafen (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 1990. 277p. (In German). Contract BMFT 07UVP01. Order Number DE91706069. Source: NTIS (US Sales Only), PC A13/MF A01.

(1) The development of the Environmental Impact Assessment (EIA) and its research (EIR) is characterized by uncertainties with regards to its contents and methodics. There are various perceptions of its functions, conditions and procedures. There are indeed several EIR-conceptions, modell-EIRs and EIR-methodics; systematic analyses of EIRs with regard to their contents and methodics are, however, seldom. (2) The analysis has the aim of identifying methodical problems in the EIA-related assessment of ecological effects and to demonstrate the required amount of research and development. (3) For that purpose - actual methodical approaches for the aggregation of information in EIRs are categorized and described, - criteria for the analysis of EIRs and their methodics are developed, methodical approaches within EIRs are analysed. (4) It has been shown that there is a broad spectrum of contents and methodics for the aggregation of information within EIRs. There is, of course, some agreement as to the subjects to be treated within an EIA. The discrepancies with regard to content and methodics are, however, so great that the acceptance of an EIA is hindered. (5) From this, the requirement for further research and development concerning methods for the aggregation of information, EIA-terminology, information profiles, prognoses and assessment problems is defined. (orig.) With 278 refs., 18 tabs., 38 figs.

50954 (ML–4136) **The impact of acidification on the economic value of recreational fishing in Quebec.** Rapport de l'analyse economique et commerciale, No.1. Michaud, L. Michaud (L.), Inc., Montreal, PQ (Canada). Mar 1989. 92p. Contract FO FP802-6-2694-01-SZ. (MICROLOG–90-03224). Source: PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

In a study of the impact of the acidification of surface waters on the economics of recreational fishing in Quebec during the year 1985, an econometric model was constructed to predict how acidification affects the demand for fishing. The research revealed that there is a significant link between the demand for fishing and the biological productivity of water bodies expressed in biomass per unit of catching effort. The study also examined the application of the travel cost approach to estimate the economic value associated with a reduction in fishing catches. There were 11.9 million fishing trips made in Quebec in 1985, representing 15.8 million angler day of fishing. The loss to anglers due to acidification is composed of both a reduction in fishing days and a decrease in the satisfaction derived by anglers who continue to fish. The combined value of these effects on the Quebec economy was estimated at $28 million for 1985. This study is considered to be primarily a test to evaluate a model which links socio-economic information and biological information. More precise data would be required to give results which could better represent the situation of acidification in the region. However, it provides a good impact analysis of the acidification of water bodies in Quebec. 23 refs., 13 figs., 17 tabs.

50955 (NBE–90-04151) **1990 annual report relating to the Canada/New Brunswick Agreement respecting a sulphur dioxide emission reduction program for the calendar year 1989.** New Brunswick Dept. of the Environment, Fredericton, NB (Canada). Mar 1990. 11p. (MICROLOG–90-04151). Source: PC New Brunswick Dept. of Municipal Affairs and Environment, 364 Argyle St., PO Box 6000, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Canada/New Brunswick Agreement, signed in 1987, added New Brunswick's participation to that of the other eastern provinces in reducing SO_2 emissions by 50%. This report summarizes the impact of long-standing provincial policies and legislation on SO_2 emissions, progress since 1980, projections for the future, control options, and monitoring efforts. New Brunswick as agreed to an annual emission target, to be achieved by 1994, of no more than 185,000 tonnes of SO_2. 85% of acid causing emissions in New Brunswick are produced by the combustion of fossil fuels to supply energy needs. Progress in controlling emissions from pulp mills, the mining and smelting industry, the Irving oil refinery, and industrial boilers is given. Current emissions estimates for these sources are included, along with with deposition trends from 1983-88 across the province. Most sectors indicate only minor changes from the previous year. The exception is N.B. Power, where emissions increased by 12%, due to continued strong in-province demand growth and support to neighbouring utilities. From 1990-94, while environmental hearings, approval processes, and construction activities proceed on the control options proposed by N.B. Power, the pulp mills and the smelter, provincial emissions will likely range between 200,000-250,000 tonnes. A cooperative program among the N.B. Dept. of the Environment, N.B. Power and Environment Canada expanded the monitoring activity and increased the number of active stations to 20 until May of 1990. 4 tabs.

50956 (OIES-EV–1) **Fossil fuel consumption and the environment.** Davison, A. Oxford Institute for Energy Studies (UK). Apr 1989. 61p. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The three major environmental problems caused by the burning of fossil fuels, air pollution, acid rain and the greenhouse effect, are discussed. Current and future patterns of energy consumption to the year 2020 are examined. Fuel substitutes for the most noxious fossil fuels, coal and oil, are considered and their advantages and drawbacks assessed. The substitutes are natural gas, renewable energy, hydro power and nuclear power. Finally, energy conservation, as a fifth option is reviewed. The overall conclusions are that a universal drive towards better fuel efficiency, which already makes economic sense, in tandem with some fuel substitution can forestall the worst effects of global warming for an appreciable period giving time for a determined research effort to commercialize renewable energy and into new ways of using fossil fuels without producing such intractable pollution problems. (UK).

50957 (PB–90-242843/XAB) **Site Enforcement Tracking System (SETs): PRP national listing by site.** Environmental Protection Agency, Washington, DC (USA). Water and Land Div. 2 Aug 1990. 2290p. Source: NTIS, PC A99/MF E99.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to the state where the site is located.

50958 (PB–90-242850/XAB) **Site Enforcement Tracking System (SETS): PRP national listing alphabetically by party name.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 2395p. Source: NTIS, PC A99/MF E99.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter are used to form the Site Enforcement Tracking System (SETS). The data include PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The alpha report lists the PRPs in alphabetical order and links the records with the site(s) where potential liability is associated.

50959 (PB–90-242868/XAB) **Site Enforcement Tracking System (SETS): Frequency by party name report.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 119p. Source: NTIS, PC A06/MF A01.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The frequency listing is arranged in the following manner. The number of sites associated with the party is indicated in the site's column. The first two characters of the site ID number constitute the state abbreviation of the site location.

50960 (PB–90-243049/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Region 4.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 245p. Source: NTIS, PC EE99/MF E99.

Set includes PB–90-243056 through PB–90-243122.

A separate abstract is included for each of 8 reports of this set.

50961 (PB–90-243056/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Alabama.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 12p. Source: NTIS, PC A03/MF A01.

See also PB–90-243064; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Alabama where the site is located.

50962 (PB–90-243064/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Florida.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 37p. Source: NTIS, PC A03/MF A01.

See also PB–90-243056 and PB–90-243072; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site.

The site report is designed to provide PRP information linked by the associated site, which appears according to Florida where the site is located.

50963 (PB–90-243072/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Georgia.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 19p. Source: NTIS, PC A03/MF A01.

See also PB–90-243064 and PB–90-243080; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Georgia where the site is located.

50964 (PB–90-243080/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Kentucky.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 97p. Source: NTIS, PC A05/MF A01.

See also PB–90-243072 and PB–90-243098; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Kentucky where the site is located.

50965 (PB–90-243098/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Mississippi.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 16p. Source: NTIS, PC A03/MF A01.

See also PB–90-243080 and PB–90-243106; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Mississippi where the site is located.

50966 (PB–90-243106/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for North Carolina.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 31p. Source: NTIS, PC A03/MF A01.

See also PB–90-243098 and PB–90-243114; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to North Carolina where the site is located.

50967 (PB–90-243114/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for South Carolina.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 24p. Source: NTIS, PC A03/MF A01.

See also PB–90-243106 and PB–90-243122; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to South Carolina where the site is located.

50968 (PB–90-243122/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Tennessee.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 9p. Source: NTIS, PC A02/MF A01.

See also PB–90-243114; Also available in set of 8 reports PC E99/MF E99, PB–90-243049.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Tennessee where the site is located.

50969 (PB–90-243148/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Illinois.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 57p. Source: NTIS, PC A04/MF A01.

See also PB–90-243155; Also available in set of 6 reports PC E99/MF E99, PB–90-243130.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Illinois where the site is located.

50970 (PB–90-243155/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Indiana.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 137p. Source: NTIS, PC A07/MF A01.

See also PB–90-243148 and PB–90-243163; Also available in set of 6 reports PC E99/MF E99, PB–90-243130.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Indiana where the site is located.

50971 (PB–90-243163/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Michigan.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 158p. Source: NTIS, PC A08/MF A01.

See also PB–90-243155 and PB–90-243171; Also available in set of 6 reports PC E99/MF E99, PB–90-243130.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Michigan where the site is located.

50972 (PB–90-243171/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Minnesota.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 56p. Source: NTIS, PC A04/MF A01.

See also PB–90-243163 and PB–90-243189; Also available in set of 6 reports PC E99/MF E99, PB–90-243130.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Minnesota where the site is located.

50973 (PB–90-243189/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Ohio.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 105p. Source: NTIS, PC A06/MF A01.

See also PB–90-243171 and PB–90-243197. Also available in set of 6 reports PC E99/MF E99, PB–90-243130.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority

List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Ohio where the site is located.

50974 (PB–90-243197/XAB) **Site Enforcement Tracking System (SETS): PRP listing by site for Wisconsin.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 2 Aug 1990. 44p. Source: NTIS, PC A03/MF A01.

See also PB–90-243189; Also available in set of 6 reports PC E99/MF E99, PB–90-243130.

When expending Superfund monies at a CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) site, EPA must conduct a search to identify parties with potential financial responsibility for remediation of uncontrolled hazardous waste sites. EPA regional Superfund Waste Management Staff issue a notice letter to the potentially responsible party (PRP). Data from this notice letter is used to form the Site Enforcement Tracking System (SETS). The data includes PRP name and address, a company contact person, the date the notice was issued, and the related CERCLA site name and identification number. SETS was created to track PRP identification at both NPL (National Priority List) and non-NPL sites. SETS does not address the range of other administrative duties related to tracking the PRP. These lists (updated quarterly) represent EPA's preliminary findings on the identities of potentially responsible parties. Inclusion on these lists does not constitute a final determination concerning the liability of any party for the hazard or contamination at any CERCLA site. The site report is designed to provide PRP information linked by the associated site, which appears according to Wisconsin where the site is located.

50975 (PB–90-249434/XAB) **Oswer-Superfund telephone directory. Directive.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Apr 1990. 36p. (EPA–9200.0-03A). Source: NTIS, PC A03/MF A01.

The document serves as a telephone directory of Superfund Headquarters and regional contacts. The directory is published on a semi-annual basis.

50976 (PB–90-249467/XAB) **Flexible funding in the regional extramural operating plan - Superfund Management Review, Recommendation No. 10. Directive (Final).** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 11 Dec 1989. 9p. (EPA–9200.3-08). Source: NTIS, PC A02/MF A01.

The directive clarifies the funding flexibility currently available to the Regions and discusses the FY-90 flexible funding initiatives and funds control process.

50977 (PB–90-249608/XAB) **Listing municipal landfills on the NPL. Directive (Final).** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 21 Aug 1987. 7p. (EPA–9320.1-09). Source: NTIS, PC A02/MF A01.

The directive outlines procedures for listing municipal landfills qualifying as Superfund sites on the National Priorities List (NPL).

50978 (PB–90-256637/XAB) **Review of nine state and federal operating permit programs. Technical report.** Stoneman, C. Duke Univ., Durham, NC (USA). Inst. of Policy Sciences and Public Affairs. 30 Oct 1989. 293p. Source: NTIS, PC A13/MF A02.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. It is intended to provide information on problems and difficulties State and EPA permitting authorities have encountered in the administration and enforcement of similar pollution permitting programs. The Clean Air Act amendments recently proposed to Congress by current administration are promoting permit programs as an alternative to the drawn-out process revising State Implementation Plans (SIPs). Under Title IV of the amendments, States will submit for approval a comprehensive operating permit program of major air pollution sources to the U.S. Environmental Protection Agency (EPA). The Title IV and V amendment requires that States permit some 10-15,000 major air pollutions sources nationwide and issue permits to over 100 sources which emit SO2. The information in the report comes principally from seven State permitting programs–Arizona, Illinois, New York, North Carolina, North Dakota, Ohio, and Oregon–which issue permits to air pollution sources; and two EPA regions–I and VI–which issue water discharge permits under the National Pollution Discharge Elimination System (NPDES) program.

50979 (PB–90-256678/XAB) **Preliminary assessment of mitigation performance under the National Environmental Policy Act (NEPA): In selected cases from Region 1, US EPA. Technical report.** Palola, E. Harvard Univ., Cambridge, MA (USA). John Fitzgerald Kennedy School of Government. 1990. 51p. Source: NTIS, PC A04/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The use of mitigation to satisfy the requirements of the National Environmental Policy Act (NEPA) for major federal actions is an important, frequently controversial, feature of the NEPA process. Increasingly, environmental impact statements (EIS) rely on mitigation to defend the feasibility of project design and selection. The Environmental Protection Agency (EPA) plays a crucial role in the NEPA process under their mandate to review and comment on proposed mitigation actions, and through negotiation with lead agencies and other parties. Wide variation exists in project proposals subject to NEPA review and in the detail given to mitigation. The report is a preliminary assessment of whether commitments to mitigate environmental damage were kept and what factors influenced mitigation performance. Four completed NEPA cases in the New England Region of EPA (Region I) were examined where mitigation was a key determinant in the selection of the final project alternative in an EIS. Research consisted of a combination of personal interviews, site visits, and review of state, federal and local documents.

50980 (PB–90-256728/XAB) **Ecosystem effects of Superfund. National Priority List sites in industrial landscapes: A framework for policy decisions. Technical report.** Savisky, T.P. Georgia Univ., Athens, GA (USA). Inst. of Ecology. 1 Dec 1989. 42p. Source: NTIS, PC A03/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. In order to comply with Superfund legislation for National Priority List Sites having ecosystem effects that are located in industrial settings the study recommends different perspectives. A review of pertinent literature was conducted in order to develop a framework for EPA personnel who are developing policy decisions in this area. It is recommended that a landscape perspective be taken in order to account for the cumulative, long term effects of the industrial setting. Such effects may be much more significant than the toxic waste site itself, and thus options such as creation or purchase of additional natural acreage elsewhere may make more ecological sense. The placing of the Superfund effort in a landscape perspective requires a national, multiagency and interdisciplinary landscape management plan in order to be feasible. Regardless of the decision made in dealing with these types of NPL sites, a broadened approach must be taken that considers long term economic effects, and the overall goal of society. Types of questions that need to be considered, as well as possible approaches that can be used to achieve these ends are given.

50981 (PB–90-258310/XAB) **SI/HRS Information Bulletin. Directive (Final).** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Apr 1989. 14p. (EPA–9200.5-302). Source: NTIS, PC A03/MF A01.

The directive is designed to inform those persons involved in the Superfund pre-remedial process of possible data collection

changes brought about by the proposed revisions to the Hazard Ranking System (HRS). The document is designed to assist Regional pre-remedial staff, State offices functioning under cooperative agreements, other Federal agencies, and contractors in conducting data collection activities during the interim period between proposal and promulgation of the revised HRS.

50982 (PB–90-258484/XAB) **ROD annual report, FY 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Apr 1990. 379p. (EPA–540/8-89/006). Source: NTIS, PC A17/MF A02.

See also report for FY88, PB–89-235212.

Provides the Regions and Headquarters with summary data on FY 89 Records of Decision (RODs), and consists of the following sections: Introduction – highlights specific accomplishments in the ROD process; ROD Summaries – describes site conditions and key contaminants, selected remedial actions, specific remedy performance standards and goals, and institutional controls for each FY 89 ROD; FY 89 ROD Summary Table – summarizes all remedial actions, capital operation and maintenance costs, and contaminated media; FY 82-FY 88 ROD Summary Table – summarizes all RODs from FY 82 through FY 88; ROD Keyword List – provides major keyword categories and their subcategories for all RODs approved to date.

50983 Industrial energy use, nonattainment and the clean air act reauthorization. Grogan, P.J. (Argonne National Lab. (US)); Garvey, D.B.; Streets, D.G. pp. 239-250 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper provides estimates of the percentage of industrial energy use located in nonattainment areas. The implications of the patterns of industrial energy use for air quality policy are discusses.

2904 Energy Resources

Refer also to citation(s) 50369, 50374, 50680, 50936, 51000, 51001, 51013, 51014, 51119, 51138, 51884

50984 (CONF-891185–1, pp. 33, Paper 18) **Electricity generation in Asia and the Pacific: Power sector demand for coal, oil, and natural gas.** Razavi, H. (World Bank, Washington, DC (USA)); Fesharaki, F. East-West Center, Honolulu, HI (USA). Resource Systems Inst.; USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Feb 1990. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. In *The Asia-Pacific coal technology conference.* 446p. Order Number DE90006339. Source: NTIS, PC A19.

This paper provides a detailed, country-by-country analysis regarding the uses of a mixed fuel energy policy. The purpose of this study is assess the future mix of fuels required for power generation in the Asia-Pacific region. This includes a projected future energy demand; a review of the present generating capacity of existing facilities; an appraisal the operating cost of electricity generated by oil, coal, gas, hydro, and nuclear power; determine the least-cost mix of energy sources which would be sufficient to meet future demand, calculate the level of electricity generation from each type of capacity; and estimate the quantity of each type of fuel which will be needed to generate the predicted demand of electricity for each generation source.

50985 (PB–90-255530/XAB) **Minerals Yearbook, 1988. Volume 1. Metals and minerals.** Bureau of Mines, Washington, DC (USA). 1990. 1084p. (BUMINES-MYB–1988-VOL-1). Source: NTIS, PC A99.

Also available from Supt. of Docs. See also PB–83-177568 and Volume 2, PB–90-255548.

Volume I of the 1988 Minerals Yearbook, covering metals and minerals, contains 79 commodity or commodity group chapters with data on approximately 90 minerals that were obtained as a result of the mineral information gathering activities of the U.S. Bureau of Mines. In addition, the volume contains chapters on mining and quarrying trends and on the statistical surveying methods used by the Bureau of Mines and a statistical summary.

50986 (QMER–E38) **Energy Quebec.** Quebec Ministere de l'Energie et des Ressources, Quebec, PQ (Canada). 1989. 32p. (MICROLOG–90-04183). Source: PC Bibliotheque du l'Assemblee Nationale, Edifice Pamphile-Lemay, Quebec, PQ, CAN G1A 1A5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This overview of the Quebec energy industry covers the development of electrical generation and its transmission, the petrochemical industry, the use of natural gas, and research and development in the fields of electrical energy, and alternate and renewable energies. Research on the use of hydrogen as an energy source, and the Tokamak-type reactor are priorities.

50987 (QMER–E39) **Energy Quebec.** Quebec Ministere de l'Energie et des Ressources, Quebec, PQ (Canada). 1989. 32p. (MICROLOG–90-04183). Source: PC Bibliotheque du l'Assemblee Nationale, Edifice Pamphile-Lemay, Quebec, PQ, CAN G1A 1A5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

This overview of the Quebec energy industry covers the development of electrical generation and its transmission, the petrochemical industry, the use of natural gas, and research and development in the fields of electrical energy, and alternate and renewable energies. Research on the use of hydrogen as an energy source, and the Tokamak-type reactor are priorities.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 50330, 50336, 50355, 50460, 50540, 50731, 50756, 50762, 50993, 51004, 51057, 51083, 51238, 51606, 51884, 52316

50988 (DOE/ER–0465T) **Advanced Energy Projects FY 1990 research summaries.** USDOE Office of Energy Research, Washington, DC (USA). Advanced Energy Projects Div. Sep 1990. 50p. Sponsored by U.S. DOE Energy Research. Order Number DE90018025. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report serves as a guide to prepare proposals and provides summaries of the research projects active in FY 1990, sponsored by the Office of Basic Energy Sciences Division of Advanced Energy Projects, Department of Energy. (JF)

50989 (OE/RT–90-03626-Vol.1) **Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.** Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. 486p. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A technology transfer conference was held to report and publicize the progress made on Ministry funded projects. Papers were presented on air quality research, water quality research, liquid and solid waste research, analytical methods and environmental socio-economics. Separate abstracts have been prepared for 7 papers from volume one of this conference.

50990 (UCRL–52000-90-7-8) **Energy and technology review, July–August, 1990.** Burnham, A.K. (ed.). Lawrence Livermore National Lab., CA (USA). 1990. 114p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000482. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report highlights various research programs conducted at the Lab to include: defense systems, laser research, fusion energy, biomedical and environmental sciences, engineering, physics, chemistry, materials science, and computational analysis. It also contains a statement on the state of the Lab and Laboratory Administration. (JEF)

2906 Nuclear Energy

Refer also to citation(s) 50647, 50838, 51005, 51636, 51637, 52610

50991 (IAE–4652-3) **Nuclear power and safety.** Kuz'min, I.I.; Sidorov, M.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 28p. (In Russian). Order Number DE91604642. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The paper deals with the problem of necessity to develop nuclear power, conceivable consequences of this development, its disadvantages and advantages. It is shown that the nuclear power is capable of supplying the world's economy with practically unlimited and the most low-cost energy resources providing the transition from the epoch of organic fuel to the epoch with another energy sources. The analysis of various factors of nuclear power effects on population and environment is presented. Special attention is focused on emergency situations at NPPs. The problem of raising the nuclear power safety is considered. 11 refs.; 5 figs.; 2 tabs.

2907 Transport and Storage

Refer also to citation(s) 50355, 50357, 50949

50992 Bimode uninterruptible power supply compatibility in renewable hybrid energy systems. Bower, W. (Sandia National Labs., Albuquerque, NM (USA)); O'Sullivan, G. *IEEE Aerospace and Electronic Systems Magazine (USA),* 5(8): 16-22 (Aug 1990). DOE Contract AC04-76DP00789.

Inverters installed in renewable hybrid energy systems are typically used in a stand-alone mode to supply ac power to loads from battery storage when the engine-generator is not being used. Similarities in topology and in the performance requirements of the standby uninterruptible power supply (UPS) system and the hybrid system suggest the UPS could be used in hybrid energy systems. Another alternative to inverters with add-on charging circuits or standby UPS hardware is the Bimode UPS. The bimode UPS uses common circuitry and power components for dc to ac inversion and battery charging. It also provides an automatic and nearly instantaneous ac power transfer function when the engine-generator is started or stopped. The measured operating and transfer characteristics of a bimode UPS in a utility system and in a hybrid system are presented. The applicability of the bimode UPS to hybrid systems and its compatibility in a PV/engine-generator hybrid system are given.

2908 Heat Utilization

Refer also to citation(s) 50998

50993 (CMHC–CE03101) **LeBreton Flats district heating: institutional issues: Demonstration report.** Gerow, L.B.; Bernstein, H. Canada Mortgage and Housing Corp., Ottawa, ON (Canada). Dec 1981. 32p. (CE–03101). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Despite the growing popularity in Europe of district heating as an alternative to conventional systems, a number of institutional barriers blocked the road to its successful implementation in Canada. These hurdles include questions of ownership, operation/administration, consumer accountability, financial arrangements, and general consumer acceptance of a new technology. In deciding on ownership, the major issues were legal. Provincial laws to be complied with included The Municipal Franchises Act, The Public Utilities Act, The Municipal Act and The Ontario Municipal Board Act. The operation and administration of the project were also beset with legal complications. The relevant laws were The Boilers and Pressure Vessels Act, and The Environmental Assessment Act. How to charge individual users (consumer accountability) raised a number of technical problems including metering and rate-setting for hot water distribution, and heat borrowing between units. The report recommends that groups planning to implement district heating are advised to allow plenty of lead time for obtaining approvals and franchising arrangements so as not to jeopardize construction schedules. 3 refs.

50994 (EBRLG–33) **Reference from the Lieutenant Governor in Council: ICG Utilities (Ontario) Ltd. Cogeneration project Boise Cascade Canada Ltd., Fort Frances: Report of the Board.** Ontario Energy Board, Toronto, ON (Canada). 21 Dec 1989. 177p. (MICROLOG–90-04274). Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $18.00 CAN; MF $10 CAN.

In April 1988, ICG Utilities (Ontario) Ltd. applied to the Ontario Energy Board (OEB) for a ruling relating to its proposed investment in a cogeneration project to be built at the pulp and paper mill of Boise Cascade Canada Ltd. in Fort Frances, Ontario. A hearing was held for approval of gas supply and exemption from compliance with an undertaking barring ICG from investing in a non-utility (non-regulated) activity. The OEB was also asked to examine the cogeneration project in relation to ICG's rate base, revenues and expenses, and use of capital cost deductions. This report summarizes the results of the hearings, covering the structure of the project investment, gas supply arrangements, project economics, shareholder considerations, risks to the utility and its ratepayers, and accounting issues. The OEB recommended ICG be allowed to invest in the cogeneration project and permitted contracts for gas supply but denied ICG's request for special accounting treatment and a separation of the ICG accounts from the cogeneration project. 3 figs., 2 tabs.

2910 Conservation

Refer also to citation(s) 51004, 51013, 51014, 51058, 51066, 51074, 51075, 51081, 51085, 52610

50995 (AD-A–223569/5/XAB) **Evaluation of electrical energy consumption and reduction potential at the 7th Army Training Command (ATC), U.S. Army, Europe. Final report.** Taylor, W.R.; Dubravec, M.A. Army Construction Engineering Research Lab., Champaign, IL (USA). May 1990. 244p. (CERL-TR-E–90/07). Source: NTIS, PC A11/MF A02.

The 7th Army Training Command (ATC), U.S. Army, Europe, has accrued increasingly higher electrical utility bills over the past few years. As is true at most installations, the 7th ATC buildings are not equipped with electricity meters so it is difficult to identify the major power consumers. To determine electrical energy use patterns and potentially find energy conservation opportunities (ECOs), the 7th ATC asked the U.S. Army Construction Engineering Research Laboratory (USACERL) to study electricity consumption at two of its communities, Grafenwohr and Hohenfels, Federal Republic of Germany. Results of the predictive modeling and field testing showed several possible ECOs at Grafenwohr and Hohenfels, such as dimming exterior lights during some hours of the night, providing better controls on oversized ventilation systems in gymnasiums, and training dining hall personnel in energy-conservative practices. A major electrical power consumer is the training ranges; however, since the training mission has priority over energy use, little can be done at this time to reduce consumption there. In the future, target ranges may become available that provide the same quality of training with a lower energy demand.

50996 (QMER/BEE–90-04351) **Energy co-ordinators in municipalities: They are profitable and desirable.** Forgues, G.; Latour, G. Quebec Ministere de l'Energie et des Ressources, PQ (Canada). Bureau des Economies d'Energie. Sep 1987. 77p. (MICROLOG–90-04351). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A study of 4 cases has shown that it is necessary and profitable to hire an energy co-ordinator to achieve substantial energy savings in townships. The City of Sherbrooke hired an energy co-ordinator from October 1983 to May 1985, and achieved energy savings of $600,000/y (or 23% of its energy expenses) from 1985 on. The city of Saint-Hyacinthe hired an energy co-ordinator in 1983; in 1986, energy savings reached $86,000 (or 4.4% of the

energy expenses) and are bound to increase. In Montreal North, although there is no official energy co-ordinator, voluntary actions are being made in the field of energy savings; the energy savings amount to $174,000/y (or about 12% of the energy expenses). The City of Saint Leonard is a pioneer in the field of retrofitting municipal vehicles to natural gas; its energy savings are $141,000/y (or about 11% of its energy expenses), and it's been estimated that these savings could be increased by $173,000/y, but this would require an energy co-ordinator; the pay-back period would then be 2.5 y, taking into account the co-ordinator's salary and the necessary investments. In conclusion, salary and other expenses connected to the hiring of an energy co-ordinator are more than compensated by the resultant savings; moreover, the media can disseminate the results thus obtained and, therefore, increase public understanding of municipal administration. 9 refs., 13 tabs.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 50339, 50375, 50936, 51004, 51014, 51028

50997 (QMER–90-04760) **Scenarios for end-use energy demand in Quebec, 1986-2006: Summary report.** Quebec Ministere de l'Energie et des Ressources, Quebec, PQ (Canada). Oct 1987. 100p. (MICROLOG–90-04760). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

As part of its studies on long term energy demand trends in Quebec, the ministere de l'Energie et des Ressources analyzed energy consumption from 1986-2006. Three different socio-economic scenarios, based on 2 economic growth assumptions (strong growth and slow growth) and 3 assumptions for increases in the price of international crude oil (major increase, moderate increase, limited increase) were simulated. Scenario 1 combines strong growth with a substantial rise in oil prices; scenario 2 is based on low growth and a moderate price increase; and scenario 3 uses a combination of strongth growth and a limited increase in oil prices. Results indicate a moderate recovery in the growth of overall energy demand (from 0.7% to 1.4%). In all 3 scenarios, energy demand will grow 2-3 times less rapidly than economic activity; electricity will become the predominant form of energy used in Quebec over the next 10 years; the importance of oil will continue to decline by an average of 30%; and the share of non-conventional energy forms will not change significantly from its current level of 8%. The relative share of industrial energy demand should increase despite improvements in the energy efficiency of the industrial sector. There does not seem to be a close relationship between residential energy consumption and the rate of economic activity or oil price increase assumptions used. As well, all 3 scenarios indicate a renewed growth in energy demand in the transportation sector. 6 tabs., 27 figs.

50998 (STEV–1989-5) **Electricity- and heat production.** Assarsson, B. Statens Energiverk, Stockholm (Sweden). Dec 1989. 134p. (In Swedish). Order Number DE91707880. Source: NTIS (US Sales Only), PC A07/MF A01.

Appendix 2 to the report 'An environmentally adapted energy system', STEV–1990-2. An extensive english summary of this report is published in the report STEV–1990-3.

This report is part of an investigation rgarding the future potential, development possibilities, environmental aspects and costs for different technologies concerning electricity and heat production. Already today there is ample access to technologies for electricity and heat production. Nuclear power could be substituted by other power production within a couple of years, provided it is possible to disregard two important restraints: environmental impact and cost. The development work is therefore mainly directed towards technologies with lesser environmental impact, higher efficiency, lower fuel consumption and greater electricity production through back pressure processes as for example cogeneration. This goals will, however, not be reached to prices lower than today. Fuel prices stays for the greater share of the electricity production cost, which means that the price trend on fuel plays a greater role than the trend in capital cost. (U.W.).

50999 (STEV–1989-R18) **The competition situation between cogeneration and heat pumps.** Isaksson, H. (K-Konsult, Stockholm (SE)); Westerlund, R. Statens Energiverk, Stockholm (Sweden). Dec 1989. 97p. (In Swedish). Order Number DE91707861. Source: NTIS (US Sales Only), PC A05/MF A01.

Basic document to the report 'An environmentally adapted energy system', STEV–1990-2.

Environmental considerations implies that the competition situation between cogeneration and heat pumps attracts much attention. In this report, three scenarios have been studied concerning different environmental charges for the release of carbon dioxide in connection with cogeneration. The competitive edge of cogeneration seems to be strengthened by the proposal that production of electric power shall be subsidized and that the CO_2-charge is excluded on fuels used for electric power production. (U.W.).

51000 (STEV–1990-2) **An environmentally adapted energy system.** Eng, T.; Loevgren, K. Statens Energiverk, Stockholm (Sweden); National Swedish Environment Protection Board, Solna (Sweden). [1990]. 78p. (SNV–3744). Order Number DE91707884. Source: NTIS (US Sales Only), PC A05/MF A01.

This report deals with Sweden's long-term capacity for establishing an environmentally adapted energy system. What requirements should be imposed on such a system? What are our options with respect to biofuels, techniques of producing electricity and heat and methods of enhancing energy efficiency? Our results are compiled in scenarios of Sweden in the year 2015 in which economic repercussions are also described. (orig.).

51001 (STEV–1990-3) **An environmentally adapted energy system: English-language summaries of appendices 1-3 of the main report.** Statens Energiverk, Stockholm (Sweden). Dec 1989. 51p. Order Number DE91707886. Source: NTIS (US Sales Only), PC A04/MF A01.

In September 1988, the National Energy Administration, Sweden and the Swedish Environmental Protection Agency were charged with the task of defining the potential features of an environmentally adapted Swedish energy supply. Their work is presented in a joint report, 'An environmentally adapted energy system'. The report is based partly on the following Appendices issued by the respective authorities: National Energy Administration; * Environmentally adapted energy scenarios, Sweden 2015, * Electricity and heat production, * Indigenous fuels. Swedish Environmental Protection Agency; * Targets for an environmentally adapted energy supply, * Biofuels from agriculture. This report contains summaries of the National Energy Administration's Appendices. The main report is also available in an English translation. (orig.).

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 50376, 50493, 50909, 50983, 51026, 51653

51002 (CREDA–2041) **Utility interconnection.** New Brunswick Energy Secretariat, Fredericton, NB (Canada). Feb 1985. 16p. (CE–03095). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

An independent study into the problems of interconnecting small power producers (chiefly wind turbines) to a large grid system is described. The project was successful in having the two large commercial power companies in the province (N.B. Power, Power Commission of the City of Saint John) draft policy regarding interconnection. These policy documents set out acceptable terms of reference for the small power producer consistent with the long term integrity of the provincial grid, safety, and buy back rate. The project also resulted in the interconnecton of two wind turbine generators. The wind generators' reports are included in the Small Scale Program as administered by the Research and Productivity Council (RPC) in Fredericton.

51003 (OEB–90-04360) **Ontario Energy Board annual report 1988/89.** Ontario Energy Board, Toronto, ON (Canada). 1989. 56p. (MICROLOG–90-04360). Source: PC Ontario Energy Board,

14 Carlton St., 9th Floor, Toronto, ON, CAN M5B 1J2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Ontario Energy Board is the provincial agency responsible for regulating the province's major energy industries, natural gas and electricity. The Board regulates the provincial natural gas industry in a variety of ways including rate setting, approval of franchise agreements and authorizing the installation of transmission lines. The Board also acts as an advisor to the Minister of Energy on matters relating to the natural gas industry as well as Ontario Hydro. The Board makes recommendations with respect to any proposed Hydro rate increases. Several of these responsibilities are described in greater detail in this report. Also included are summaries of the major decisions taken by the Board during the year. These decisions relate to such matters as security of supplies, costs of gas, bulk power rates, natural gas rate structures, and gas storage and transport facilities. An outline of the public hearing process is included.

51004 (OME–301082-12/11-89) **Ontario Ministry of Energy annual report, 1988/89.** Ontario Ministry of Energy, Toronto, ON (Canada). 1989. 48p. (MICROLOG–90-04898). Source: PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Ontario Ministry of Energy is responsible for devising policies and implementing programs to keep Canada's largest energy consuming market attuned to energy markets and abreast of energy developments. The Ministry has four broad objectives: to ensure an adequate, reasonably priced energy supply, one that has minimal environmental impact, to promote energy conservation and efficiency, to encourage research and development of new energy services and technologies, and to advise the provincial government on energy policy issues. This report highlights the year's activities of the Ministry and provides some insight into how it may influence the future Ontario energy picture. Some of these highlights include major amendments to the Power Corporation Act, the principal legislative authority for Ontario Hydro's operation; demonstration projects in industrial energy efficiency and vehicle fuel substitution; establishment of a non-utility generation advisory council; sponsoring of an international conference on small hydroelectric power plants; and adoption of new environmental standards for petroleum refineries.

51005 (STEV–1989-4) **Environmentally adapted energy scenarios. Sweden 2015.** Bergendahl, P.A.; Sohlman, Aa.; Petsala, B. Statens Energiverk, Stockholm (Sweden). Dec 1989. 319p. (In Swedish). Order Number DE91707878. Source: NTIS (US Sales Only), PC A14/MF A01.

Appendix 1 to the report 'An environmentally adapted energy system', STEV–1990-2. An extensive english summary of this report is published in the report STEV–1990-3.

How can Sweden manage to combine phasing out of nuclear power with advanced ambitions within the field of environmental protection? To answer this question, the National Energy Administration and the Swedish Environmental Protection Agency were assigned to elucidate how an environmentally adapted energy system should be designed. In the investigation a number of scenarios for the Swedish energy system in AD 2015 is discussed. This report is one of three appendices to the main report, and outlines the assumptions and calculations behind the different scenarios, for users as well as for producers. A rough estimate have been done concerning societal additional costs for the different alternatives. Finally, a general discussion is made about how an effective environmental- and energy policy should be designed. (U.W.).

51006 (STEV–1989-R23) **East-west cooperation in the environment in Europe-problems, strategies, perspectives.** Schreiber, Helmut. Statens Energiverk, Stockholm (Sweden). Dec 1989. 82p. Order Number DE91707869. Source: NTIS (US Sales Only), PC A05/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

This report deals with problems and developments in the field of East-West cooperation in Europe. The major emphasis is put on the cooperation in the environmental field. Nevertheless it has to be stated that developments in the environmental field should not be separated from the developments in other fields of possible cooperation like economy, science and culture. The report is divided in five chapters and an appendix. In the first chapter the results of the study will be discussed on the basis of the research questions given by the National Energy Administration. The second chapter contains some background information on some basic trends in environmental problems in Eastern Europe; the German Democratic Republic, Poland, Czechoslovakia and the Soviet Union are the countries described here. Special emphasis is laid on Poland, a country of particular interest for Sweden. In the third chapter answers are given to the question, why East-West environmental cooperation is necessary. In chapter four existing forms of cooperation are surveyed. In this chapter, the author deals mainly with cooperations in the field of environmental protection, but he also gives an overview on cooperations in other fields. Four countries are included in this overview: the FGR, France, Great Britain and the Netherlands. In chapter five, questions of general concern for East-West environmental cooperation are discussed. Appendix 1 gives an overview of the more important bilateral agreements between Eastern and Western European countries. Appendix 2 lists the institutions and names of the persons we interviewed. Appendix 3 gives an overview on the literature on East-West environmental cooperation in Europe.

51007 (YM–32-1/79-37-1989-O5F) **Acid rain.** Canada Library of Parliament, Ottawa, ON (Canada). Research Branch. 19 May 1989. 26p. (MICROLOG–90-03019). Source: PC Canadian Government Publishing Centre, Supply and Services Canada, Ottawa, ON, CAN K1A 0S9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report was produced for the use of Members of Parliament and House of Commons committees. The document describes the formation of acid rain, emissions of acidifying pollutants in North America, the growth of the problem and its environmental effects on aquatic and terrestrial ecosystems, human health and man-made structures. Areas of Canada which are most susceptible are identified. Actions taken by Parliament are given, including the formation of a sub-committee on acid rain and the passing of Bill C-51 in 1980 to amend the Clean Air Act, bringing it closer to a similar law in the U.S. A chronology of government responses to acid rain at the international, national and provincial level, is given. 12 refs.

2940 Fossil Fuels

Refer also to citation(s) 50380, 50395, 50468, 50469, 50470, 50471, 50472, 50476, 50488, 50493, 50956, 51003, 52610

51008 (AE/PD–1/321) **Alberta Petroleum Incentives Program Fund annual report, 1988/89.** Alberta Energy, Edmonton, AB (Canada). Petroleum Div. 1989. 11p. (MICROLOG–90-04703). Source: PC Alberta Petroleum Incentives Program Fund, Communications Section, 855 - 8th Ave., SW, Calgary, AB, CAN T2P 3P1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Alberta Petroleum Incentives Program (APIP) was created in November 1981. APIP's objective is to encourage the exploration and development of Alberta's petroleum and natural gas resources. The program also supports work on tertiary oil recovery projects. Under the program, eligible applicants may obtain APIP incentive payments equal to a percentage of their incurred eligible costs and expenses, including exploration and development expenses for oil and gas wells; geological and geophysical expenses, and development drilling and asset costs related to tertiary oil recovery projects. This report of the year's activities includes an accounting of the total of $2,217 million in incentives paid, of which ca $1.3 million was for exploration drilling. The financial statements of the APIP Fund are also included.

51009 (CIM/PS–CE03173, pp. 6.1-6.20, Paper 88-39-06) **Trends in crude oil and natural gas reserves additions rates and marginal supply costs for western Canada.** Bowers,

B. (National Energy Board (Canada)); Kutney, R. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A review is presented of the trends in crude oil and natural gas reserves additions rates and associated marginal supply costs for western Canada. Extrapolations of these trends can be used to estimate economic hydrocarbon potentials. It has been found that an exponential relationship proposed by Bowers (1979) is the most useful for analysis of western Canadian data. Historically, the reserves additions rates of both crude oil and natural gas have decreased over time and consequently the marginal supply costs have increased. Extrapolations of these historical trends indicate that significant volumes of conventional crude oil and natural gas, which could be economically recovered, remain to be discovered. Average expectations amount to about 500 million m_3 of conventional light and heavy crude oil and 65 exajoules of marketable natural gas. 6 refs., 24 figs.

51010 (CIM/PS–CE03173, pp. 9.1-9.18, Paper 88-39-09) **Lake Erie: Offshore natural gas exploration and development opportunities in Ontario.** Fox, J.N. (Ontario Ministry of Natural Resources, ON (Canada)); Trevail, R.A.; Rybanski, R.M. Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

Lake Erie is the fourth largest of the Great Lakes covering an area of 25,665 km^2, of which 12,768 km^2 are in Ontario. The oil and natural gas rights under that part of Lake Erie are owned by the province. The province's land tenure system of exploratory licences and production leases is outlined. An overview of offshore drilling, completion and production operations in Lake Erie is also presented, including typical costs associated with such operations. When examining any exploration and development opportunities it is essential that consideration be given to the various factors that influence the attractiveness of such opportunities. To this end, there is provided a brief description of the geology, reservoir and production characteristics of producing horizons underlying the lake, a summary of the lake's remaining proven and potential natural gas reserves, and an outline of the advantages enjoyed by Ontario natural gas producers with respect to gas pricing and marketing. These advantages include the availability of large tracts of leasable land under the lakes, low rents and royalties, low exploration and development costs, and favorable natural gas prices. 11 refs., 12 figs.

51011 (EACNLMT–90-03090) **Potential issues associated with shipping oil and gas through the Labrador Sea and Strait of Belle Isle.** Environmental Advisory Committee on Newfoundland and Labrador Marine Transportation, NF (USA). Sep 1989. 93p. (MICROLOG–90-03090). Source: PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is made to answer a series of simple questions about the environmental and socio-economic impacts of a project to ship oil and gas from the Beaufort Sea to southern markets, by arctic tankers, through the Labrador Sea and the Strait of Belle-Isle. It is the product of an environmental review by a joint-panel, based on a survey of the human communities on the Labrador coast and in the Strait of Belle-Isle. It deals with the management of shipping, tanker movements, tanker specifications and safety concerns, damage caused by tankers (cause, effect and responses), the reporting of oil spills, contingency planning, environmental protection legislation, the effects of the existing tanker traffic, marine services, compensation between local people, government and industry for the control of tanker traffic. The report is written both in Inuktitut and in English. 22 figs.

2950 Hydrogen and Synthetic Fuels

51012 (QMER–90-04355) **A matter of technology.** Quebec Ministere de l'Energie et des Ressources, Quebec, PQ (Canada). [1990]. 98p. (MICROLOG–90-04355). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An overview of the leading Quebec firms and institutions involved in new technologies and alternative energies is given. The list is divided into categories of manufacturers, consulting engineers, and research and development. Each organization listed and the projects they've conducted are briefly described. These include Energex fuel, the Fournelle solar collector, Pyrotek incinerators, and the Uraken dryer, as well as research in such fields as heat pumps, biological and biotechnological recycling processes, hydrogen energy use, and seawater desalination.

2960 Electric Power

Refer also to citation(s) 50339, 50369, 50370, 50371, 50372, 50374, 50375, 50378, 50744, 50776, 50911, 50984, 50998, 51003, 51060, 51066, 51074, 52610

51013 (DOE/BP–1405) **1990 Resource Program.** USDOE Bonneville Power Administration, Portland, OR (USA). Jul 1990. 35p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000206. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is a summary providing an overview of the analysis, thought process, and conclusions of the Resource Program. This summary is accompanied by a Technical Report, under separate cover, that provides a more in-depth discussion of the information presented here. Another companion document published under separate cover, the Resource Program Public Comment Summary and BPA's Response, provides a detailed summary of public comments on the Draft 1990 Resource Program and BPA's response to those comments. For a thorough understanding of how BPA arrived at the following conclusions, all three documents should be consulted. The 1990 Resource Program describes the actions Bonneville Power Administration (BPA) will take to develop new resources to meet the power requirements of its customers. The main focus is to determine what BPA should do in Fiscal Years (FY's) 1992 and 1993. This document presents Energy Resource budgets for these years. However, much care has been taken to define near-term actions aimed at meeting BPA's long-term resource needs. consequently, proposed program actions are presented for FY's 1994 through 1997. In addition, the 1990 Resource Program addresses some resource-related policy issues.

51014 (DOE/BP–1406) **1990 Resource Program technical report.** USDOE Bonneville Power Administration, Portland, OR (USA). Jul 1990. 169p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000207. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This Technical Report is a detailed presentation of the actions Bonneville Power Administration (BPA) will take to develop new resources to meet the power requirements of its customers. The primary focus of this report is on what BPA will do in Fiscal Years (FY's) 1992 and 1993. However, much care has been taken to define near-term actions aimed at meeting BPA's long-term needs. An aggressive, steadily increasing conservation program forms the foundation of the 1990 Resource Program and resource acquisitions for FY's 1992 and 1993. BPA's commitment to a steady ramp-up of the conservation program is key to achieving the least-cost approach to resource development, and to making the conservation resource deliverable in the long run. By itself, conservation can meet much of the likely range of load growth that BPA faces. A diverse mix of generation resources in small increments is the second cornerstone of the 1990 Resource Program. These

generation resources can meet the rest of the likely range of BPA resource needs. Finally, a Resource Contingency Plan prepares BPA to reliably meet load in the event that load growth exceeds the likely range. 14 figs., 27 tabs.

51015 (DOE/BP–1430) **Puget Sound Reinforcement Project: Planning for peak power needs: Scoping report, Part A, Summary of public comments.** USDOE Bonneville Power Administration, Portland, OR (USA); Snohomish County Public Utility District, WA (USA); Puget Sound Power and Light Co., Bellevue, WA (USA); Seattle City Light, WA (USA); Tacoma Dept. of Public Utilities, WA (USA). Light Div. Jul 1990. 22p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE91000160. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report summarizes public participation in the environmental scoping process for the Puget Sound Reinforcement Project, a Bonneville Power Administration (BPA) and Puget Sound area utilities study of voltage stability in northwestern Washington state. The environmental scoping phase of the Puget Sound project consisted of a series of public meetings and a public comment period. The content of these meetings is summarized in 2.0, Public Involvement. In 3.0, Comment Summary, the report summarizes comments received via meetings, mail and phone. The report ends with a description of the next steps in the project. Chapter 4.0, describes the decision process to be used by BPA and area utilities. Chapter 5.0 describes opportunities for public participation in decisions to be made about the future reliability of Puget Sound's electricity supply.

51016 (DOE/BP–1437) **Operations, Maintenance, and Replacement 10-Year Plan, 1990–1999.** USDOE Bonneville Power Administration, Portland, OR (USA). Aug 1990. 39p. Sponsored by U.S. DOE Bonneville Power Administration. Order Number DE91000352. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In 1988 Bonneville Power Administration (BPA) began work on this Operations, Maintenance, and Replacement 10-Year Plan to develop a levelized program that would assure high system reliability. During the Programs in Perspective (PIP) meetings in the late summer and fall of 1988, many of the concerns to be addressed in an Operations, Maintenance, and Replacement Plan were identified. Following these PIP meetings BPA established internal work groups. During the winter and spring of 1989, these work groups developed technical background and issue papers on topics that ranged from substation maintenance to environmental protection. In addition, a customer forum group was established and met on several occasions to review work on the plan, to offer ideas and points of view, and to assure that BPA understood customer concerns. Based on recommendations from the work group reports and customer input, BPA's O&M Management Team developed the draft Operations, Maintenance, and Replacement 10-Year Plan that was released for public comment during the spring of 1990. During the public review period, BPA received a number of written comments from customers and the interested public. In addition, special meetings were held with interested customers. This final Operations, Maintenance, and Replacement 10-Year Plan reflects BPA's response to customers and interested public on each topic discussed in the 10-Year Plan. The plan is a distillation of BPA's strategies to achieve a levelized program over 10 years.

51017 (DOE/BP/13795–26) **Commercial equipment loads: End-Use Load and Consumer Assessment Program (ELCAP).** Pratt, R.G.; Williamson, M.A.; Richman, E.E.; Miller, N.E. Pacific Northwest Lab., Richland, WA (USA). Jul 1990. 181p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AC06-76RL01830 ;AC79-83BP13795. Order Number DE91000423. Source: NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The Office of Energy Resources of the Bonneville Power Administration is generally responsible for the agency's power and conservation resource planning. As associated responsibility which supports a variety of office functions is the analysis of historical trends in and determinants of energy consumption. The Office of Energy Resources' End-Use Research Section operates a comprehensive data collection program to provide pertinent information to support demand-side planning, load forecasting, and demand-side program development and delivery. Part of this on-going program is known as the End-Use Load and Consumer Assessment Program (ELCAP), an effort designed to collect electricity usage data through direct monitoring of end-use loads in buildings. This program is conducted for Bonneville by the Pacific Northwest Laboratory. This report provides detailed information on electricity consumption of miscellaneous equipment from the commercial portion of ELCAP. Miscellaneous equipment includes all commercial end-uses except heating, ventilating, air conditioning, and central lighting systems. Some examples of end-uses covered in this report are office equipment, computers, task lighting, refrigeration, and food preparation. Electricity consumption estimates, in kilowatthours per square food per year, are provided for each end-use by building type. The following types of buildings are covered: office, retail, restaurant, grocery, warehouse, school, university, and hotel/motel. 6 refs., 35 figs., 12 tabs.

51018 (DOE/EIA–0226(90/06)) **Electric Power Monthly, June 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 13 Sep 1990. 188p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000031. Source: NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.

The EPM is prepared by the Electric Power Division; Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration (EIA), Department of Energy. This publication provides monthly statistics at the national, Census division, and State levels for net generation, fuel consumption, fuel stocks, quantity and quality of fuel, electricity sales, and average revenue per kilowatthour of electricity sold. Data on net generation are also displayed at the North American Electric Reliability Council (NERC) region level. Additionally, company and plant level information are published in the EPM on capability of new plants, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fuel. Quantity, quality, and cost of fuel data lag the net generation, fuel consumption, fuel stocks, electricity sales, and average revenue per kilowatthour data by 1 month. This difference in reporting appears in the national, Census division, and State level tables. However, at the plant level, all statistics presented are for the earlier month for the purpose of comparison. 40 tabs.

51019 (EPRI-CU–6966) **Least-cost planning in the United States, 1990: Final report.** Chamberlin, J. (Barakat and Chamberlin, Inc., Oakland, CA (USA)); Fry, T.; Geiger, L. Electric Power Research Inst., Palo Alto, CA (USA); Barakat and Chamberlin, Inc., Oakland, CA (USA). ©Sep 1990. 52p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report surveys the advancement of least-cost planning for electric utilities on a state-by-state basis. Summary maps compare motivational factors, such as relative rate changes, least-cost planning framework, and capacity surpluses or shortages. 21 refs., 6 figs.

51020 (OH–90-04730) **Ontario Hydro annual report, 1989.** Ontario Hydro, Toronto, ON (Canada). Apr 1990. 53p. (MICROLOG–90-04730). Source: PC Ontario Hydro Research Division, Research Publications Office, 800 Kipling Ave., Toronto, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Ontario Hydro is a provincial crown corporation with broad powers to generate, supply and deliver electricity throughout the province. This report provides a history and description of the current electric power generation, transmission and distribution system of Ontario Hydro, its role in the provincial economy, and its programs in environmental control, international cooperation, development of resources and services, energy conservation, rate structure, public safety, and personnel management. Statistical data are presented, where applicable, in graphic form. Highlights of 1989 include a 5% increase in electricity demand, the release of a 25-year plan for supplying electricity, signing of a 22-year agreement with Manitoba Hydro to purchase 1,000 MW of power beginning in the year 2000, and introduction of new energy efficiency programs. The most significant section of the report is devoted to financial information, with important points summarized.

Data on production, assets, and liabilities are given in both graphic and tabular form. 13 figs., 2 tabs.

51021 (OH/RD–90-04243) **Ontario Hydro statistical yearbook. Supplement to the eighty-first annual report for the year 1988.** Ontario Hydro, Toronto, ON (Canada). Research Div. [1988]. 259p. (MICROLOG–90-04243). Source: PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Ontario Hydro is an Ontario Crown corporation which operates 80 hydraulic, fossil and nuclear generating stations, and an extensive power grid across Ontario to meet the province's demands for electric energy. This annual summary describes its operations, planning strategy, generation and transmission projects, environmental initiatives, purchases, research, and employment equity measures during 1988. Detailed statistics for each area cover both the current year and the previous year. Financial statements are included for both Ontario Hydro and associated municipal utilities. The 1988 annual peak demand was 12.1% higher than the 1987 peak, brought on by a very cold December. The construction of the tritium removal facility within the Darlington nuclear complex was completed, although the sale of tritium to other jurisdictions has not yet been approved. An Environment Division was established, plans were completed to reduce acid gas emissions to the 1994 target levels, and all spraying of herbicides was eliminated on brush under power lines, along roadsides, and near residential lots. 8 figs., 18 tabs.

51022 (PNL-SA–17700) **Purifying mixed-use electrical consumption data.** Taylor, Z.T.; Pratt, R.G. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 12p. Sponsored by Bonneville Power Administration; U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-900833–11: ACEEE summer study on energy efficiency in buildings, Pacific Grove, CA (USA), 26 Aug - 1 sep 1990). Order Number DE91000154. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes several analytical techniques for obtaining pure end-use load information from mixed end-use consumption data. This process is frequently necessary to make metered data useful to those involved in electric utility load forecasting and conservation assessment. Analyses based on traditional thermal models can be greatly augmented by these data sets if the measured entities correspond to those for which modeled estimates are necessary. We present two scenarios in which greater end-use resolution was needed than was available in existing data. The first involves segregating measured total HVAC consumption data into its heating, cooling, and ventilation constituents. The second discusses a technique to separate measurements of mixed equipment consumption into equipment type categories. These techniques were successfully applied to a large number of metered commercial buildings. We conclude with suggestions for extending these techniques to applications involving high-time-resolution building total data. 3 refs., 8 figs.

51023 (PNL-SA–18484) **Observations on residential and commercial load shapes during a cold snap.** Gillman, R.A. (US-DOE Bonneville Power Administration, Portland, OR (USA)); Sands, R.D.; Lucas, R.G. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-900833–8: ACEEE summer study on energy efficiency in buildings, Pacific Grove, CA (USA), 26 Aug - 1 sep 1990). Order Number DE90017867. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Electricity consumption in the Pacific Northwest reaches a peak during days of extremely cold weather, due to the large amount of electric space heat in the region. The cold snap of February 1989 prompted the Bonneville Power Administration to examine hourly load shape data by end-use, comparing average winter days to peak winter days. It was observed that end-use load shapes can be very different on peak days, with implications for demand side management programs. The End-Use Load and Consumer Assessment Program (ELCAP) has collected hourly end-use electricity data for several hundred residences and commercial buildings in the Pacific Northwest. Analysis of ELCAP data indicates that most space heat load shapes have a higher load factor on a peak day than on an average winter day. Peak day load shapes are compared with average day load shapes for single-family residences and several commercial building types. In the residential sector, it was observed that electricity consumption increased for all end-uses, not just space heat, during the cold snap. Load shapes for newer homes, those built to Model Conservation Standards, did not exhibit the increase in space heat load factor found in older homes. 4 tabs., 5 figs.

51024 (SPC–90-04714) **SaskPower annual report, 1989.** Saskatchewan Power Corp., Regina, SK (Canada). Mar 1990. 25p. (MICROLOG–90-04714). Source: PC Saskatchewan Power Corporation, 2025 Victoria Ave., Regina, SK, CAN S4P 0S1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

SaskPower is a provincially owned crown corporation, established in 1950 to provide electricity and natural gas to the residents of Saskatchewan. In 1989, the natural gas portion of the corporation was sold off and SaskPower's primary objective is to meet the electrical energy needs of Saskatchewan residents in an economical, safe reliable, efficient and environmentally responsible manner. This service is to be provided at rates that cover all costs and contribute to short- and long-term financial health of the corporation. SaskPower's board of directors is appointed by the provincial government and represents a broad spectrum of Saskatchewan residents. This report presents relative production and consumpiion statistics relating to gas and electricity operations, as well as the year's developments in management and service practices. Major projects in 1989 included completion of a Saskatchewan-Alberta tie line, installation of buried cable to serve 3,286 farms, continued work on the Shand coal-fired power station, and building of the first provincial storage site for polychlorinated biphenyls. Financial statements are also included.

51025 (STEV–1989-R22) **Future energy use in dwellings and premises.** Sandberg, E. Statens Energiverk, Stockholm (Sweden). Dec 1989. 79p. (In Swedish). Order Number DE91707867. Source: NTIS (US Sales Only), PC A05/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

This report treats different scenarios concerning future consumption of heat and electricity in dwellings and premises. The cases studied are * low economic growth: +1%/year, * High economic growth, +2-2.7%/year. This is the so called basic scenario. Proposed carbon dioxide charges adds two so called environmental scenarios * SEK 0.50/kg CO2 and SEK 0.70/kg SO2 respectively, coupled to the two growth alternatives. Existing as well as planned dwellings and premises are treated and the consumption described for * Electricity for households and premises, * Heating, * Converting, * Cogeneration. (U.W.).

51026 **Deregulation and diversification of utilities.** Crew, M. (Rutgers Univ. (US)). 224p. Kluwer Academic Publishers, Norwell, MA (USA) (1989).

This book deals with some of the major current issues of diversification and deregulation facing public utilities and regulators. The current movement for competition and deregulation in telecommunications is discussed. The importance of deregulation and diversification is addressed.

51027 **Competitive bidding for electric power: Comparing evaluation methods.** Goldman, C.A. (Applied Science Div., Lawrence Berkeley Lab., Berkeley, CA (US)); Kahn, E.P. *Energy Systems and Policy (USA)*, 13(3): 169-192 (Jul 1989).

Competitive bidding for new electric supply is a recent but rapidly growing trend. This study focuses on utility bidding systems that provide potential suppliers with explicit self-scoring procedures. These systems facilitate comparisons of the utility's treatment of various nonprice factors: uncertainties associated with the project development process, project operational characteristics and their benefits to the utility, environmental impacts, fuel choice and flexibility, and economic risks to rate payers because of front-loaded bids. The authors illustrate differences among the bid evaluation systems of three utilities by scoring the same set of eight bids in

hypothetical auctions. The authors analysis suggests that developing more realistic measures of project viability is a key area that needs improvement in utility bidding systems.

2980 Consumption and Utilization

Refer also to citation(s) 51018, 52610

51028 (DOE/EIA-0035(90/06)) **Monthly energy review, June 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 26 Sep 1990. 143p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE91000361. Source: NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

The Monthly Energy Review presents current data on production, consumption, stocks, imports, exports, and prices of the principal energy commodities in the United States. Also included are data on international production of crude oil, consumption of petroleum products, petroleum stocks, and production of electricity from nuclear-powered facilities.

51029 (STU-I-752-1989) **Energy consumption in industry: An update for the period 1984-87.** Cordi, I.; Ewetz, J.; Wernelind, Aa. Swedish National Board for Technical Development, Stockholm (Sweden). Sep 1989. 117p. (In Swedish). Order Number DE91707843. Source: NTIS (US Sales Only), PC A06/MF A01.

Energy consumption in Swedish industry 1984-1987 is analyzed and compared to figures from earlier periods. The industry is classified in eleven branches - mining, food, textile, wood products, pulp and paper, grafics, chemistry, non-metal mining, iron and steel, non-ferrous metals, and engineering. Investment in energy conservation is also analyzed. (L.E.).

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 50721, 51012

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

Refer also to citation(s) 51209

51030 (CONF-9006105-10) **Leakage resistance and current inferred from CDIF operating data.** Rosa, R.J. Avco-Everett Research Lab., Everett, MA (USA); Montana State Univ., Bozeman, MT (USA). [1990]. 5p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70507. From 28. symposium on engineering aspects of magnetohydrodynamics; Chicago, IL (USA); 26-28 Jun 1990. Order Number DE91000015. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Axial leakage current is difficult to measure directly. Spacial and temporal variations tend to cloud the interpretation of local measurements such as the current or voltage between any two neighboring electrodes. Also the measurement process itself tends to affect the result in an unpredictable manner. Therefore it is desireable to seek an indirect method that is based upon averages over a distance equivalent to one duct diameter or more, does not perturb the system, and is based upon data already collected. An indirect method is described here together with the results obtained when it is applied to nearly all CDIF runs. When correlated, the data suggest that leak current is primarily a function of Hall parameter and Faraday current while only weakly dependent upon axial field. Possible reasons for this discussed. 4 refs., 7 figs.

51031 (DOE/ID/12735-T10) **Magnetohydrodynamic projects at the CDIF [Component Development and Integration Facility]: Quarterly technical progress report, April 1-June 30, 1990.** MSE, Inc., Butte, MT (USA). [1990]. 16p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-88ID12735. Order Number DE91000848. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This quarterly technical progress report presents the tasks accomplished at the Component Development and Integration Facility during the third quarter of FY90. Areas of technical progress this quarter included: coal system development; seed system development; test bay modification; channel power dissipation and distribution system development; integrated topping cycle/proof-of-concept current controls project; oxygen system storage upgrade; iron core magnet thermal protection system checkout; TRW slag rejector/CDIF slag removal project; stack gas/environmental compliance upgrade; coal-fired combustor support; 1A channels fabrication and assembly; support of Mississippi State University diagnostic testing; test operations and results; data enhancement; data analysis and modeling; technical papers; and projected activities. 2 tabs.

3003 Thermoelectric Generators

51032 **Electrodes for sodium heat engine/Amtec systems.** Schmatz, D.J. (Ford Motor Co., Dearborn, MI (USA). Research Staff); McBride, J.R.; Novak, R.F.; Grab, G.A.; Hunt, T.K. pp. 729-730 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107-: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The sodium heat engine (SHE) is a thermoelectric conversion device whose operation relies on the high sodium ion conductivity and low electronic conductivity of sodium beta ″-alumina solid electrolyte (BASE). Positive electrodes for SHE systems must satisfy several stringent demands. In addition to supplying electrons from the load to the electrode-beta ″-alumina interface, the electrode must pass neutral sodium atoms from the interface to the vacuum side of the electrode, where sodium evaporates to the condenser surface. SHE operating characteristics require good electrodes to have exceptionally low impedance to both electron and neutral sodium flow. In addition, electrodes must be chemically and mechanically stable in the high temperature (800-1000°C) sodium vapor environment. Long term electrode stability is one of the few remaining fundamental issues involving the SHE. The authors discuss the performance and durability of three electrode systems. The authors also discuss the effect of electrode size on power output relative to electrode edge effects, lateral sodium ion flow in the electrolyte, resistive losses in the negative current collector and temperature.

3005 Fuel Cells

Refer also to citation(s) 51108, 51207, 51208, 51209, 51210, 51212

51033 (DOE/MC/25170-2861) **Improved anode catalysts for coal gas-fueled phosphoric acid fuel cells: Final report.** Kackley, N.D.; McCatty, S.A.; Kosek, J.A. Giner, Inc., Waltham, MA (USA). Jul 1990. 52p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-88MC25170. Order Number DE90009683. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The feasibility of adapting phosphoric acid fuel cells to operate on coal gas fuels containing significant levels of contaminants such as CO, H_2S and COS has been investigated. The overall goal was the development of low-cost, carbon-supported anode fuel cell catalysts that can efficiently operate with a fossil fuel-derived hydrogen gas feed contaminated with carbon monoxide and other impurities. This development would reduce the cost of gas cleanup necessary in a coal gas-fueled PAFC power plant, thereby reducing the final power cost of the electricity produced. The problem to date has been that the contaminant gases typically adsorb on catalytic sites and reduce the activity for hydrogen oxidation. An advanced approach investigated was to modify these alloy catalyst systems to operate efficiently on coal gas containing higher levels of contaminants by increasing the alloy catalyst impurity tolerance and ability to extract energy from the CO present through (1) generation of additional hydrogen by promoting the CO/H_2 water shift reaction or (2) direct oxidation of CO to CO_2 with the same result. For operation on anode gases containing high levels of CO, a Pt-Ti-Zn and Pt-Ti-Ni anode catalyst showed better performance over a Pt baseline or G87A-17-2 catalyst. The ultimate aim of this effort was to allow PAFC-based power plants to operate on coal gas fuels containing increased contaminant concentrations, thereby

decreasing the need for and cost of rigorous coal gas cleanup procedures. 4 refs., 15 figs., 10 tabs.

51034 (EPRI-ER–6983) **Doped cerium oxide for molten carbonate fuel cell cathodes: Final report.** De Guire, M.R. (Case Western Reserve Univ., Cleveland, OH (USA)); Shingler, M.J.; Dincer, E. Electric Power Research Inst., Palo Alto, CA (USA); Case Western Reserve Univ., Cleveland, OH (USA). ©Sep 1990. 64p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

Donor-doped CeO_2 was studied as a cathode material for the molten carbonate fuel cell. The electrical conductivity of Nb-doped CeO_2 was measured as a function of dopant level (0.80-1.3 cat%), temperature (600–900°C), and partial pressure of oxygen (10^{-12} –1 atm). The conductivity of Ta- and W-doped cerium oxide was also measured in air from 600 to 900°C. The corrosion resistance of pure and Nb-doped CeO_2 in molten carbonate was studied as a function of atmosphere and material preparation procedure, and characterized using electron microscopy and solubility measurements. Nb-doped CeO_2 showed excellent corrosion resistance to molten carbonate, when silicate grain boundary phases were eliminated. The electrical conductivity is near the target value of 0.1 $\Omega^{-1}cm^{-1}$ at 650°C and $<10^{-1}$ atm oxygen pressure. For $pO_2 \geq$ 0.2 atm, $CeNbO_4$ precipitation sharply reduces the electrical conductivity. Preliminary in-cell testing of tape cast CeO_2/Nb electrodes showed no evidence of corrosion. Electrical losses, however, were higher than for lithiated nickel oxide (NiO/Li). Replacing Nb with W or Ta resulted in substantially higher electrical losses and greater corrosion resistance than NiO/Li. 42 refs., 19 figs., 1 tab.

51035 (RISO-M–2867) **Solid oxide fuel cell interconnection materials based on $LaCrO_3$.** Gordes, P. Risoe National Lab., Roskilde (Denmark). Materials Dept. Jan 1990. 80p. Order Number DE91707362. Source: NTIS (US Sales Only), PC A05/MF A01.

The report gives a survey of the literature on $LaCrO_3$ doped with alkaline earth metal oxides MgO, CaO and SrO. The main emphasis is put on electrical conductivity and thermal expansion as function of doping level because these properties are most important for the application of this type of materials as the interconnector of solid oxide fuel cells. Furthermore some experimental work is reported. SrO and BaO doped $LaCr_3$ powders were prepared by a liquid mix based on the metal nitrates, citric acid and ethylene glycol. Samples were sintered and characterized by a number of techniques including X-ray diffractometry, differential thermal analysis, dilatometry, conductivity measurements and several more. (author) 47 ills., 53 refs.

51036 Corrosion in fuel cells: An overview. Kinoshita, K. (Lawrence Berkeley Lab., CA (USA). Applied Science Div.). pp. 167 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC03-76SF00098. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Development of fuel-cell technology has focused on five systems, which are generally classified according to the type of electrolyte: phosphoric acid fuel cell (PFAC), molten carbonate fuel cell (PAFC), and solid oxide fuel cell (SOFC). These fuel cells are listed in the approximate order of increasing operating temperature, ranging from ~80°C for FEFC, ~100°C for AFC, ~200°C for PAFC, ~650°C for MCFC, and ~1000°C for SOFC. One factor that limits the operating life of these fuel cells is corrosion of cell components, which becomes a significant issue because the lifetimes of commercial systems is expected to be about 40,000 hours. The extent of corrosion varies with the type of fuel cell and its operating conditions.

51037 Interfacial effects in monolithic solid oxide fuel cells. Dees, D.W. (Argonne National Lab., IL (USA). Chemistry and Materials Science and Technology Div.); Balachandran, U.; Dorris, S.E.; Heiberger, J.J.; McPheeters, C.C.; Picciolo, J.J. pp. 783-784 of Electrochemical Society 1989. Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-31-109-ENG-38. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The monolithic solid oxide fuel cell (MSOFC) under development is an oxide-ceramic structure in which appropriate electronic and ionic conductors are fabricated in a honeycomb shape similar to a lock of corrugated paperboard. The fundamental building block for the structure is an individual fuel cell made of a thin three-layer ceramic composite. The composite is a yttria-stabilized zirconia (YSZ cermet anode and a strontium-doped lanthanum manganite cathode, shown in this paper. The electrochemical performance of the three-layer composite is limited by the bulk resistance of the electrolyte and interfacial resistances of each of the electrode-electrolyte interfaces. Reduction of these interfacial resistances is important to obtaining high power densities with the MSOFC. In this paper, AC impedance studies are used to examine the fuel cell's electrochemical performance and to separate the bulk resistance from the interfacial resistances.

51038 Structural, sintering and electrical properties of the perovskite-type $(La,Sr)(Cr,Mn)O_3$. Koc, R. (Missouri Univ., Rolla, MO (USA). Dept. of Ceramic Engineering); Anderson, H.U.; Howard, S.A.; Sparlin, D.M. pp. 799 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

This paper reports the $La_{1-x}Sr_xMnO_3$ system investigated to determine the best composition of high temperature electrode and fuel cell interconnector applications. Structural studies were made using the a Rietveld pattern-fitting-structure-refinement algorithm with x-ray powder diffraction data. The pattern fitting nature of this technique aided in the identification of phases and allowed the precise determination of the lattice parameters for the component phases. For compositions annealed at temperatures below 1200°C a single orthorhombic phase was found for x less than 0.55 while a single rhombohedral phase existed for x greater than 0.60 and a mixture of the two phases existed for intermediate compositions. Lattice parameters were shown to vary smoothly as a function of atomic substitution. Sintering studies were done in air at temperatures below 1500°C. Significant improvement in densification was observed with substitution of 50% Mn for Cr, and 95% TD was achieved with substitution of 70% Mn for Cr. Electrical conductivity (d.c.) measurements were made as a function of temperature and oxygen activity.

51039 Structural, sintering and electrical properties of the $YCrO_3$-$YMnO_3$-$YCoO_3$ system. Seward, S. (Missouri Univ., Rolla, MO (USA). Dept. of Ceramic Engineering); Carini, G.; Anderson, H.A. pp. 798 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The $YCrO_3$-$YMnO_3$-$YCoO_3$ system due to its electrical conductivity has great potential as a high temperature electrode. In particular it is very attractive for cathode and interconnect application in the high temperature solid oxide fuel cell (SOFC). The electrolyte of the SOFC is Y stabilized ZrO_2 so it is anticipate that the diffusion of Y during fabrication will be less of a problem than the currently employed $LaMnO_3$ and $LaCrO_3$. It is shown that $YCrO_3$ behaves very similarly to $LaCrO_3$ both in fabrication and towards reduction. However, preliminary data suggests that $YCrO_3$ is more stable towards reduction than $LaCrO_3$. The mutual solubility limits between the members of the system are discussed and the influence of composition on the thermal expansion, sinterability and electrical conductivity are presented.

51040 Mixed-conducting oxide electrodes for solid oxide fuel cells. Lios, S.S. (Pennsylvania Univ., Philadelphia, PA (USA)); Worrell, W.L. pp. 773 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Yttria-stabilized zirconia-titania solutions are novel mixed-conducting oxides in which both oxygen ions and electrons are mobile. The authors discuss how particularly attractive potential applications of these materials are as electrodes in solid oxide fuel cells. With the current electrodes exhibiting only electronic conductivity, the charge transfer reactions are restricted to regions or lines

where the gas, electrode and electrolyte phases meet. With mixed-conducting oxide electrodes, the charge-transfer reactions between the gas and the electrons occur over the entire electrode surface. Thus, polarization losses at the electrode-electrolyte interfaces will be reduced significantly due to the large increase in reaction area.

51041 Solid oxide fuel cell electrodes based on In_2O_3-$PrO_{1.83}$-ZrO_2. Bates, J.L. (Pacific Northwest Lab., Richland, WA (USA). Materials Science and Technology Dept.); Griffin, C.W.; Weber, W.J. pp. 790 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC06-76RL01830. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Cathodes or air electrodes for solid oxide fuel cells require a high electronic conductivity and must be thermally and structurally compatible with Y_2O_3 stabilized ZrO_2 electrolyte. Cell performance can also benefit if the cathode: is a mixed conductor with sufficient ionic conductivity to enhance change transfer by enlarging the active electrode and electrolyte interfacial area; and has a structure and thermal expansion similar to the electrolyte for simultaneous fabrication and high interface contact. This paper reports on work to investigate compositions and structures in the In_2O_3-$Pro_{1.83}$-ZrO_2 system as potential SOFC cathodes properties.

51042 Design and performance of tubular solid-oxide fuel cells. Maskalick, N.J. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). pp. 815-816 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Electrochemical cells employing yttria-stabilized zirconia electrolyte are presently being manufactured for field-service testing at the multi-kW level. Single cells which, when series-parallel interconnected, combine to form multi-kW modules, are examined in detail to quantify processes affecting available running power. These processes involve power losses across internal resistance, most of which are accounted for by known resistivities of the material employed. Other major power losses are due to diffusion of gases through the porous components of the cell. These power losses depend on the corresponding voltage drops designated η_{ir}, η_{i}, η_{d} and η_{x}. Methods employed to determine these quantities are described, along with examples describing the effects of temperature.

51043 Cathode for molten carbonate fuel cell. Kaun, T.D.; Mrazek, F.C. To Dept. of Energy, Washington, DC (USA). USA Patent 4,939,111/A/. 3 Jul 1990. Filed date 8 Jun 1989. USA Patent patents application 7-362,982. Int. Cl. H01M 4/88. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This paper describes a method of forming a cathode for a molten carbonate fuel cell. It comprising: mixing substantially equal quantities of first and second particulate materials having diameters of about 1 micron, and heating the mixture to cell operating temperatures in the presence of a carbonate electrolyte to sinter the mixture with the first material sintering to form a skeletal structure coated by particles of the second material to form a cathode having a stable porosity in the range of from about 60% to about 70% by volume at steady-state cell operating conditions.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

Refer also to citation(s) 50734, 50940, 51013, 51014, 51017, 51023, 51025

51044 (BFR-D–4-1990) **Thermal research in the field of building physics with application to buildings.** Bankvall, C. (Swedish National Testing Institute, Boraas (SE)). Swedish Council for Building Research, Stockholm (Sweden). 1990. 21p. Project BFR-880096-4. Order Number DE91707840. Source: NTIS (US Sales Only), PC A03/MF A01.

The objective of this project has been to develop an overall programme for all aspects of building-physics-related thermal research. The intention of the programme is to establish the right conditions for proper thermo-technical performance of buildings. This will affect indoor climate, durability of the structure and energy use levels. Results will be continuously disseminated to the building sector in the form of knowledge and design aids. The programme will establish a basis of knowledge and experience which will be consolidated by further, long-term, work. Current problems will be tackled, with the work changing as new problems appear. The report describes the scope of the programme. Areas in which research is needed in the fields of Materials, Parts/Design of Buildings and Climate Screen/Climate Load are described. Particular attention is paid to information and training needs. Forms of working and organisational aspect of the research programme itself are discussed, as are resources, interested parties and financing.

51045 (BFR-D–10-1990) **Ventilation and airtightness in low-rise residential buildings: Analyses and full-scale measurements.** Blomsterberg, Aa. (Lund Univ. (SE). Dept. of Building Science). Swedish Council for Building Research, Stockholm (Sweden). Apr 1990. 221p. Project BFR-851090-5. Order Number DE91707893. Source: NTIS (US Sales Only), PC A10/MF A01.

This report examines how the airtightness affects the ventilation, the influence of ventilation on the energy balance, methods of determining the ventilation and the performance of different ventilation systems. Six different modern house are analysed. Air exfiltration should be very low for many reasons. It is very difficult to recover heat from exfiltrating air. Air infiltration can impair thermal comfort, and air exfiltration can cause moisture problems. In order to obtain the same low air exfiltration rate in all houses, the airtightness requirements to be complied with must be different. A house with natural ventilation should preferably be much much leakier than the requirement of the Swedish Building Code, probably above 10 air changes per hour at 50 Pa, to meet the ventilation rate requirement of 0.5 air change per hour i.e. there will be wide variations above and below this value. Exhaust fan ventilation requires somewhat better airtightness than 3.0. Houses with exhaust-supply ventilation should be much tighter, probably below 1.0 air change per hour. The outdoor air ventilation can be determined with the constant concentration tracer gas technique, although sometimes underestimated. A simplified theoretical single-zone model can generate reasonable estimations of ventilation. For detailed information on air flows a multi-zone network model can be very useful. It is recommended that predictions of ventilation should be coupled with tracer gas measurements. Determination of the ventilation and the energy balance, by using a constant air change rate for the mechanical and/or natural ventilation, is in most cases inaccurate unless the house is very tight. (author) (76 refs.).

51046 (BFR-R–1-1990) **Terrace houses at Valdemarsro, Malmoe: Energy and indoor climate analysis.** Lange, E. (Lund Univ. (SE). Dept. of Building Science). Foreign Office and Ministry of Economic Warfare, London (UK). May 1990. 219p. (In Swedish). Project BFR-851090-5. Order Number DE91707822. Source: NTIS (US Sales Only), PC A10/MF A01.

32 terrace houses at Malmoe, Sweden, have been studied regarding indoor climate and energy consumption. It is shown that a very low energy consumption can be achieved through conventional technology if adequate thermal insulation and heat recovery of ventilation air is applied. A heating power of 2 kW is sufficient, but in practice much more energy was used than expected, due to defects in the water based heating system. Real possibilities for control were nil, and the inhabitants had very small possibilities for choosing indoor temperature or mastering the energy consumption. In a test where the heating system was substituted for direct electric heating a fifty percent reduction in energy consumption was achieved. (L.E.).

51047 (BFR-R–48-1990) **Noise from heatpumps and refrigeration machinery: Localization of sound bridges by measuring mechanical intensity.** Ljunggren, S. (DNV Ingemansson AB, Stockholm (SE)); Sahlin, P.; Johansson, Melker. Swedish Council for Building Research, Stockholm (Sweden). 1990. 38p. (In

Swedish). Project BFR-871170-6. Order Number DE91707888. Source: NTIS (US Sales Only), PC A03/MF A01.

Measurements have been performed in heat pump and refrigeration plants in order to localize the contact points between the machinery and the frame of the building. In these measurements, a new technique was used employing a turnable probe containing two accelerometers. The probe was mounted in the frame in a number of positions around the suspected sound bridge. With the help of a two-channel FFT-analyser, the intensity and direction of the sound was then determined, which made it possible to identify the sound bridges. The purpose of the project was to test the applicability of this method at the rather difficult conditions of heat pump and refrigeration installations. (L.E.).

51048 (BFR-T-4-1990) **Building and Health: Indoor climate and energy economy.** Johnson, B.G.; Kronvall, J.; Lindvall, T.; Wallin, A.; Weiss Lindencrona, H. Swedish Council for Building Research, Stockholm (Sweden). 1990. 172p. (In Swedish). Order Number DE91707799. Source: NTIS (US Sales Only), PC A08/MF A01.

The aim of the report is to provide a summary of today's level of knowledge of health problems associated with the indoor climate and their relation to energy economy and new energy technology. (22 figs., 9 tabs., 101 refs.) (O.S.).

51049 (BNL–52249) **Emissions characteristics of modern oil heating equipment.** Krajewski, R.; Celebi, Y.; Coughlan, R.; Butcher, T.; McDonald, R.J. Brookhaven National Lab., Upton, NY (USA). Jul 1990. 45p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. Order Number DE90018031. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Over the last 10 years there have been some very interesting developments in oil heating. These include higher static pressure burners, air atomizing nozzles, low firing rate nozzles, low heat loss combustion chambers and condensing boilers and furnaces. The current data base on the emissions characteristics of oil-fired residential heating equipment is based primarily on data taken in the 1970's. The objective of the work described in this report is to evaluate the effects of recent developments in oil-fired equipment on emissions. Detailed emissions measurements have been made on a number of currently available residential oil burners and whole systems selected to represent recent development trends. Some additional data was taken with equipment which is in the prototype stage. These units are a prevaporizing burner and a retention head burner modified with an air atomizing nozzle. Measurements include No_x, smoke numbers, CO, gas phase hydrocarbon emissions and particulate mass emission rates. Emissions of smoke, CO and hydrocarbons were found to be significantly greater under cyclic operation for all burners tested. Generally, particulate emission rates were found to be 3 to 4 times greater in cyclic operation than in steady state. Air atomized burners were found to be capable of operation at much lower excess air levels than pressure atomized burners without producing significant amounts of smoke. As burner performance is improved, either through air atomization or prevaporization of the fuel, there appears to be a general trend towards producing CO at lower smoke levels as excess air is decreased. The criteria of adjusting burners for trace smoke may need to be abandoned for advanced burners and replaced with an adjustment for specific excess air levels. 17 refs., 15 figs., 6 tabs.

51050 (BRE-BR–150) **Building Regulations: conservation of fuel and power - the 'energy target' method of compliance for dwellings.** Anderson, B.R. Building Research Establishment Scottish Lab., East Kilbride (UK). 1989. 9p. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This document sets out, for dwellings, the 'energy target' method of complying with the Building Regulations in the United Kingdom on conservation of fuel and power due to come into force in 1990, in the form of a 'worksheet' and it also provides the data needed for calculations. For convenience the worksheet has also been implemented for use on a hand-held calculator and on IBM compatible micro-computers. (author).

51051 (CREDA–2006) **Madawaska Regional Correctional Center woodchip fired boiler and auxiliaries.** Cook, G. New Brunswick Energy Secretariat, Fredericton, NB (Canada). 8 Mar 1985. 39p. (CE–03093). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A waste-wood fired heating system was installed at the Madawaska Regional Correctional Center, St. Hilaire, N.B. to demonstrate: the technical and operational feasibility of wood-waste to provide for the heating and domestic hot water requirements of the facility; and the cost effectiveness of wood waste as a source of fuel instead of No.2 heating oil. The fully automated heating system utilizes a fuel mixture of hardwood chips and sawdust (40/60 ratio) having an average moisture content between 35 and 40% on a wet basis. The system was commissioned in December 1982 and has continued to operate without any major problems since that time. The simplicity of the system operation and the lack of operator attention that is required to supervise and maintain the system was demonstrated. The objectives of this demonstration project have been adequately realized, and it has been shown that significant savings in fuel costs can be achieved by burning wood residue instead of oil. The installation of the wood fired boiler at this institution has resulted in an annual saving in fuel costs of approximately $39,000, by using 524 tonnes of wood chips and sawdust to replace 132,132 liters of heating oil. At current fuel costs this represents a saving of approximately 75%. 15 figs., 2 tabs.

51052 (CREDA–2039) **Combustion test facility program.** Fraser, T. New Brunswick Research and Productivity Council, Fredericton, NB (Canada). Jan 1985. 109p. (CE–03094). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This demonstration investigated the energy efficiencies of currently utilized or available domestic heating equipment whether they be of the oil, gas or wood-burning varieties. This included not only an evaluation of new energy efficient designs but also concerned investigation into the potential for upgrading the older oil-fired system. It has been demonstrated that it is possible to raise the steady state efficiency of an oil-fired appliance to roughly 80% by the application of certain devices and techniques. Specifically, a group of four residential furnaces was upgraded from an average of 69.5% to a level of 78.9%. In each case fuel consumption was decreased, yielding an average simple payback period of 1.95 years on the retrofit. Similarly, it has been shown that efficiencies (steady state) of 80% or better are also attainable when combusting wood residue. Selection of the proper size, shape and moisture of the particulate wood fuels for the burner is the key to success. The products of incomplete combustion have been found to be reduced (by as much as 4-5 times) from the levels encountered when burning stick wood. A second retrofit project for oil-fired furnances is recommended, not only to evaluate newly available conservation devices, but also to further increase awareness of the value of furnace upgrading. Similarly, extension of the development of wood particulate fuel combustors will aid with their adoption by the public. Development should focus on fuel quality and combustion technology. Testing for certification purposes will also be important. 15 figs., 10 tabs.

51053 (CREDA–2050) **Energy efficient church.** Enerplan Consultants Ltd., Moncton, NB (Canada). Feb 1985. 21p. (CE–03102). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

St. Michael's Church, a design based on the geodesic dome, has proven to be very economical in terms of energy consumption. The building has been designed and built with energy efficiency in mind. The building envelope, heating and cooling systems, domestic hot water system and lighting systems have all been used to demonstrate energy conservation technology. The geodesic dome has a lower exterior surface area to floor area ratio than a conventional box shape. The heat loss or gain potential of this building is therefore less, due to less transfer area compared to conventionally shaped churches. Useable floor area remains the same. The exterior is insulated to R-40 (RSI 7.2) with fibreglass batt and urethane foam. The slab is insulated to 4 feet from the wall perimeter with 2 inches of styrofoam. Heating and cooling is done by air to air heat

pumps with auxiliary electric heat for very cold weather. Domestic hot water is provided by an instaneous water heater. Lights are high intensity metal halide indirect lighting for the main area and energy saving fluorescent lighting for entries. Energy consumption in this all-electric facility was 7.6 kilowatt hours per square foot for the year from June, 1983 to May, 1984 inclusive. 2 tabs.

51054 (CREDA–2051) **Co-op housing retrofit.** Housing Alternatives, Inc., St. John's, NF (Canada). Jan 1985. 45p. (CE–03106). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This multi-unit residential rehabilitation project consists of 17 co-op housing units with some ancillary spaces, i.e. laundry facilities, storage, etc. The 18,000 sq. ft., 100 year old masonry building was completely renovated using specific energy conservation techniques. The following major items were undertaken: improvement of the building envelope and provision of an efficient, controllable heating and lighting system. The proposed project demonstrated the viability of rehabilitating older city buildings for housing projects when due consideration was given to energy efficiency and conservation during renovation. The results of this project should also demonstrate to owners of similar projects, and to the general public, methods of reducing domestic energy consumption through feasible retrofits. The project was monitored for one year, along with six other rehabilitated residential buildings, and the information collected was compared on a cost per degree day per square foot basis. Energy consumption in the building was considerably reduced, resulting in annual savings of $16,558, with a simple payback of 7.0 years. 20 figs., 3 tabs.

51055 (CREDA–2059) **Energy retrofit: 19th century multi-unit.** Basic Design Ltd., Sussex, NB (Canada). Feb 1985. 31p. (CE–03104). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A project to comprehensively retrofit a large three storey 19th century frame structure in Sussex, New Brunswick was undertaken. The proposed energy retrofit was to confront high energy costs (1981-82 oil cost $4,500) in two ways: reduce heat loss, and generate heat more efficiently and cheaply. Reduction of heat loss was managed through air-tightening and insulation. More flexible and efficient heat generation resulted from utilizing a wood chip burning Kerr 'Titan' solid fuel boiler with the existing oil furnace as back up, and separate leased hot water heaters for each apartment in the building. The system has been a success in that oil costs have been reduced considerably in comparison with previous years. Lack of availability of chip fuel in Sussex area has forced the use of 2 ft. by 4 ft. logs as the main heat source. The complexity of installation of the wood boiler and its intergration with the existing oil furnace has caused an increase in labour and costs not initially anticipated. 4 figs., 8 tabs.

51056 (CREDA–2061) **Energy efficient retrofit of a municipal building's Codiac transit bus garage.** Enerplan Consultants Ltd., Moncton, NB (Canada). [1985]. 42p. (CE–03103). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Codiac Transit Bus Garage, approximately 23,500 square feet in area, was retrofitted with a new roof and heating system. The new roof was installed on the indoor parking section of the garage only. Sloped insulation was used with a single ply roofing membrane to overcome past problems with leaks due to pooling of rainwater. A gas fired radiant tube heating system was used in the indoor garage and service garage to replace suspended hot air furnaces. Three high efficiency propane fired boilers and a gas fired domestic hot water heater were used to replace the oil fired units used previously for office and shop space heating and domestic hot water heating. The new heating system has proven to be a satisfactory and effective alternative to the conventional oil fired systems common in warehouses and garages. Mechanics find their work environment quite comfortable. The new roof installation has yet to prove itself over a longer period of time. One of the key advantages of the single ply roofing membrane is its durability and low maintenance costs. Post-retrofit energy reduction for October to December 1984, inclusive, adjusted for degree days, was 22.4% for 1984 versus 1982, and 19.8% for 1984 versus 1983. However, due to the high cost of propane in Moncton, energy cost actually increased, by 3.5% over 1982, and 6.9% over 1983. Therefore, the heating aspect of this project is very attractive when natural gas or propane costs are competitive with oil. 12 figs., 4 tabs.

51057 (DOE/BP–1417) **Construction cost analysis for the Residential Construction Demonstration Project, Cycle II.** Barnett, C.; Thor, P. USDOE Bonneville Power Administration, Portland, OR (USA). Jun 1990. 163p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000192. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Residential Construction Demonstration Project (RCDP) is designed to demonstrate new residential building techniques and product innovations which advance the stage-of-the-art in constructing energy-efficient electrically heated residences. A secondary purpose is to obtain documented cost and energy savings data from which to make accurate assessments of the cost-effectiveness of various conservation innovations. The project solicits participation of regional homebuilders by offering them financial incentives for constructing homes to the Model Conservation Standards (MCS) and including at least one "innovation." The innovations are determined by BPA and the States prior to construction and represent construction techniques or energy saving products that might reduce the cost of building MCS homes, or expand the options available to builders in achieving MCS levels of energy efficiency in homes. Besides covering some of the additional risk for employing the innovation, the incentive payment guarantees that builders will provide certain amounts of information regarding the cost and acceptability of building the homes. In addition, an incentive is paid to homeowners for their participation in data collection efforts following construction. Several"one-time" tests were performed on the houses and homeowners were required to report energy consumption and temperature data on a weekly basis for approximately 18 months. BPA and the States compile the information obtained from the builders and homeowners. Access to this data is provided for the purpose of analyzing the cost and performance of the RCDP homes, as well as understanding the value of the various innovations that are tested. 25 tabs., 4 figs.

51058 (DOE/SF/17960–T4) **Energy efficient industrialized housing research program: Summary of FY 1989 research activities.** Berg, R. (Oregon Univ., Eugene, OR (USA). Center for Housing Innovation); Brown, G.Z.; Finrow, J.; Kellett, R.; McDonald, M.; McGinn, B.; Ryan, P.; Sekiguchi, Tomoko; Chandra, S.; Elshennawy, A.K.; Fairey, P.; Harrison, J.; Maxwell, L.; Roland, J.; Swart,.Oregon Univ., Eugene, OR (USA). Center for Housing Innovation. Feb 1990. 59p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC03-89SF17960. Order Number DE91000109. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report summarizes three documents: Multiyear Research Plan, Volume I FY 1989 Task Reports, and Volume II Appendices. These documents describe tasks that were undertaken from November 1988 to December 1989, the first year of the project. Those tasks were: (1) the formation of a steering committee, (2) the development of a multiyear research plan, (3) analysis of the US industrialized housing industry, (4) assessment of foreign technology, (5) assessment of industrial applications, (6) analysis of computerized design and evaluation tools, and (7) assessment of energy performance of baseline and advanced industrialized housing concepts. While this document summarizes information developed in each task area, it doesn't review task by task, as Volume I FY 1989 Task Reports does, but rather treats the subject of energy efficient industrialized housing as a whole to give the reader a more coherent view. 7 figs., 9 refs.

51059 (DOE/SF/17960–T4-Vol.1) **Energy efficient industrialized housing research program: Volume 1, FY 1989 task reports.** Berg, R. (Oregon Univ., Eugene, OR (USA). Center for Housing Innovation); Brown, G.Z.; Finrow, J.; Kellett, R.; McDonald, M.; McGinn, B.; Ryan, P.; Sekiguchi, Tomoko; Chandra, S.; Elshennawy, A.K.; Fairey, P.; Harrison, J.; Mazwell, L.; Roland, J.;

Swart,.Oregon Univ., Eugene, OR (USA). Center for Housing Innovation. Dec 1989. 235p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC03-89SF17960. Order Number DE91000110. Source: NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This document describes the research work completed in five areas in fiscal year 1989. (1) The analysis of the US industrialized housing industry includes statistics, definitions, a case study, and a code analysis. (2) The assessment of foreign technology reviews the current status of design, manufacturing, marketing, and installation of industrialized housing primarily in Sweden and Japan. (3) Assessment of industrialization applications reviews housing production by climate zone, has a cost and energy comparison of Swedish and US housing, and discusses future manufacturing processes and emerging components. (4) The state of computer use in the industry is described and a prototype design tool is discussed. (5) Side by side testing of industrialized housing systems is discussed.

51060 (EPRI-CU-6962-Vol.1) **Heat pump thermal distribution systems: Volume 1, System analyses: Final report.** Sarkisian, P.; Cohen, B.; Popeika, A. Electric Power Research Inst., Palo Alto, CA (USA); TECOGEN, Inc., Waltham, MA (USA). ©Aug 1990. 202p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

A comprehensive study was made to determine the most cost-effective thermal distribution system for heat pumps in residential applications. The study included, but was not limited to, consideration of air, water, and refrigerant distribution systems in a wide variety of configurations. First costs as well as operating cost for the most practical candidate systems were determined. Consideration of new heat pump concepts such as ground-coupled, non-azeotropic refrigerant, and bivalent systems were also included. Detailed estimates were made of all non-conventional heat pump components to yield heat pump costs. Layouts of various distribution systems for two standard houses were costed in detail using established costing methods. Operating costs for the best candidate systems were found using DOE-2 load data and computer simulations developed at Tecogen. Study results revealed two promising non-conventional thermal distribution system concepts. The first one, rectangular flex duct, is a viable alternative to galvanized sheet metal duct, primarily due to its low installation costs. Its use is recommended in single-zoned and also multiple-zoned applications, its greatest benefits are in zoned systems, because the costs for additional zones are small. This system also lends itself well to use in electric-gas hybrid systems. 17 refs., 64 figs., 35 tabs.

51061 (EPRI-CU-6962-Vol.2) **Heat pump thermal distribution systems: Volume 2, Appendixes: Final report.** Sarkisian, P.; Cohen, B.; Popeika, A. Electric Power Research Inst., Palo Alto, CA (USA); TECOGEN, Inc., Waltham, MA (USA). ©Aug 1990. 219p. Sponsored by Electric Power Research Institute. Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

A large volume of information on conceptual heat pump systems, component costs and expected operating costs were generated for a wide variety of heat pump systems during this study. Detailed results of this work, too lengthy to be reported in a single volume, have been included in these appendices, which are designated as Volume II of this study. Schematics of possible heat pump and thermal distribution system interactions are included in Appendix B, Matrix of Possible Systems. Appendix C includes the expected cost breakdowns for the systems studied. Operating costs were generated for both the zoned and non-zoned systems. DOE-2 was used to model the 1500 ft^2 ranch house which served as the non-zoned building and the 2300 ft^2 colonial that was divided into two zones. The DOE-2 input decks are given in Appendix D. The heating and cooling load information from the DOE-2 model was used as an input to the simulations for air and hydronic systems. The hour-by-hour simulation output information includes the power requirements for the heat pump, blowers, pumps and auxiliary heating. Appendix E lists two of the simulation programs used. Simulation results for the most practical systems are included in tabular form in Appendix F.

51062 (EPRI-CU-6972-Vol.1) **Proceedings: Ventilation workshop: Volume 1, Recommendations.** Electric Power Research Inst., Palo Alto, CA (USA); Energy International, Inc., Bellevue, WA (USA). ©Sep 1990. 144p. Sponsored by Electric Power Research Institute. (CONF-8911236–Vol.1: Ventilation workshop, Golden, CO (USA), 13 Nov 1989). Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of the Ventilation Workshop was to identify ventilation technology research needs with the objective of improving energy utilization efficiency while maintaining a productive and healthful environment. Attendees included researchers, manufacturers, utilities, and designers from both the residential and commercial market sectors. The three-day workshop included over 30 brief technical presentations and several working group sessions. Workshop participants identified more than 40 specific projects addressing important ventilation technology needs.

51063 (EPRI-CU-6972-Vol.2) **Proceedings: Ventilation workshop: Volume 2, Presentations.** Electric Power Research Inst., Palo Alto, CA (USA); Energy International, Inc., Bellevue, WA (USA). ©Sep 1990. 466p. Sponsored by Electric Power Research Institute. (CONF-8911236–Vol.2: Ventilation workshop, Golden, CO (USA), 13 Nov 1989). Source: Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of the Ventilation Workshop was to identify ventilation technology research needs with the objective of improving energy utilization energy while maintaining a productive and healthful environment. Attendees included researchers, manufacturers, utilities, and designers from both the residential and commercial market sectors. The three-day workshop included over 30 brief technical presentations and several working group sessions. Workshop participants identified more than 40 specific projects addressing important ventilation technology needs. Individual projects are processed separately for the data bases.

51064 (IBP-WB-53/1990) **German cooperation in the 'Preparation Phases' of the IEA projects 'Building Energy Analysis Tools' (SHC-program) and 'Thermal Modelling' (BCS-program).** Erhorn, H.; Szerman, M. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima. 1 Mar 1990. 28p. (In German). Contract BMFT 033-8961-A. Order Number DE91706281. Source: NTIS (US Sales Only), PC A03/MF A01.

The result accuracy and useability of building energy calculation programs plays an important role for the development and testing of materials, components and techniques which promise for the operation of buildings an energy conservation potential and the increased use of solar energy. The evaluation and development of such complex programs is very expensive and needs a lot of time. Therefore it is sensible to check existing internationally used programs for their capability, accuracy and useability range and to extend these programs by necessary algorithms which have to be developed. The necessity of a further development of existing calculation possibilities has been equally seen by the IEA-Committees 'Solar heating and cooling (SHC)' and 'Energy conservation in building and community systems (BCS)'. Therefore the executive committees concerned decided to initiate the following projects 'Building Energy Analysis Tools (SHC)' and 'Thermal Modelling (BCS)'. In a feasibility phase of one year on which is reported in the following the work programs had to be defined and coordinated. (orig./UA).

51065 (LBL–25393) **Thermal energy storage for cooling of commercial buildings.** Akbari, H. (Lawrence Berkeley Lab., CA (USA)); Mertol, A. Lawrence Berkeley Lab., CA (USA). Jul 1988. 39p. Sponsored by U.S. DOE Conservation & Renewable Energy; US Agency for International Development. DOE Contract AC03-76SF00098. (CONF-8806403–1: NATO advanced study institute on energy storage systems, Cesme (Turkey), 27 Jun - 8 jul 1988). Order Number DE91000179. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The storage of "coolness" has been in use in limited applications for more than a half century. Recently, because of high electricity costs during utilities' peak power periods, thermal storage for cooling has become a prime target for load management strategies.

Systems with cool storage shift all or part of the electricity requirement from peak to off-peak hours to take advantage of reduced demand charges and/or off-peak rates. Thermal storage technology applies equally to industrial, commercial, and residential sectors. In the industrial sector, because of the lack of economic incentives and the custom design required for each application, the penetration of this technology has been limited to a few industries. The penetration rate in the residential sector has been also very limited due to the absence of economic incentives, sizing problems, and the lack of compact packaged systems. To date, the most promising applications of these systems, therefore, appear to be for commercial cooling. In this report, the current and potential use of thermal energy storage systems for cooling commercial buildings is investigated. In addition, a general overview of the technology is presented and the applicability and cost-effectiveness of this technology for developed and developing countries are discussed. 28 refs., 12 figs., 1 tab.

51066 (LBL–29478) **From comfort to kilowatts: An integrated assessment of electricity conservation in Thailand's commercial sector.** Busch, J.F. Jr. Lawrence Berkeley Lab., CA (USA). Aug 1990. 121p. Sponsored by US Agency for International Development. DOE Contract AC03-76SF00098. Order Number DE91000359. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Thailand serves as a case study of the potential to conserve electricity in the fast-growing commercial sectors of the tropical developing world. We performed a field study of over 1100 Thai office workers in which a questionnaire survey and simultaneous physical measurements were taken. Both air-conditioned and non-air-conditioned buildings were included. We analyzed Thai subjective responses on the ASHRAE, McIntyre and other rating scales, relating them to Effective Temperature, demographics, and to rational indices of warmth such as PMV and TSENS. These results suggest that without sacrificing comfort, significant energy conservation opportunities exist through the relaxation of upper space temperature limits. To investigate the potential for conserving energy in a cost-effective manner, we performed a series of parametric simulations using the DOE-2.1D computer program on three commercial building prototypes based on actual buildings in Bangkok; an office, a hotel, and a shopping center. We investigated a wide range of energy conservation measures appropriate for each building type, from architectural measures to HVAC equipment and control solutions. The best measures applied in combination into high efficiency cases can generate energy savings in excess of 50%. Economic analyses performed for the high efficiency cases, resulted in costs of conserved energy of less than and internal rates of return in excess of 40%. Thermal cool storage, cogeneration, and gas cooling technology showed promise as cost-effective electric load management strategies.

51067 (LBL–29479) **From comfort to kilowatts: An integrated assessment of electricity conservation in Thailand's commercial sector: Volume 2: Technical appendix.** Busch, J.F. Jr. Lawrence Berkeley Lab., CA (USA). Aug 1990. 190p. Sponsored by US Agency for International Development. DOE Contract AC03-76SF00098. Order Number DE91000183. Source: NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This document contains Appendix A, B, and C. In Appendix A, we are working as part of a research project with King Monkut's Institute of Technology, Thonburi, and the University of California, Berkeley (USA) to determine how people respond to the thermal environment inside buildings. We have prepared a short questionnaire which will survey thermal comfort. Our plan is to survey each building during each of three seasons over this year (e.g. hot, rainy, and cool seasons). Appendix B contains supporting technical documentation on conservation potential and Appendix C contains documentation on utility impacts.

51068 (NME–90-03771) **Organizing and financing energy efficiency projects in public buildings: Proceedings of a seminar.** Mercy Hospital and Medical Center, Chicago, IL (USA). [1989]. 45p. (CONF-8803277–: Organizing and financing energy efficiency projects in public buildings, St. John's (Canada), 29 Mar 1988; MICROLOG–90-03771). Source: PC Newfoundland Dept. of Mines, Geological Survey Branch, P.O. Box 4750, St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A seminar was held in March 1988 to introduce the energy performance contracting (EPC) concept to a diverse group with various responsibilities for the operation of provincial facilities. Speakers explained the application of the process to energy efficiency retrofits for public buildings and outlined procedures, discussed benefits, and gave advice concerning EPC projects. This document presents a series of questions and answers highlighting the main points of the discussion, followed by the written notes of the seminar speakers. EPC is a business arrangement in which a private sector company provides an energy user with a comprehensive package of services (design, engineering, training, monitoring, financial, etc.) associated with the implementation of an energy management program. The user makes no capital payment for the project, and the company is reimbursed for its services from savings generated from the venture. Separate abstracts have been prepared for three papers from this seminar.

51069 (NME–90-03771, pp. 15-27) **Federal perspective on energy performance contracting.** Ritcey, R. Mercy Hospital and Medical Center, Chicago, IL (USA). [1989]. (CONF-8803277–: Organizing and financing energy efficiency projects in public buildings, St. John's (Canada), 29 Mar 1988; MICROLOG–90-03771). In *Organizing and financing energy efficiency projects in public buildings: Proceedings of a seminar.* 45p. Source: PC Newfoundland Dept. of Mines, Geological Survey Branch, P.O. Box 4750, St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Energy performance contracting (EPC) is defined as a business arrangement in which a private sector company provides an energy user with a comprehensive package of services associated with the implementation of an energy management program in exchange for all or part of the savings generated. This paper describes the nature of EPC, the responsibilities of the energy service company, the preparation of an implementation plan and the benefits involved. The Canadian (EPC) industry was founded in Quebec about 7 years ago, and the most active buyers have been hospitals, universities and municipal governments. Short descriptions are given of 8 companies involved, followed by details of federal government support strategy, and experience in opening up the federal government market to the industry, including the development of standardized requests for proposals, the criteria to be met by the company, and the lessons learned so far.

51070 (NME–90-03771, pp. 29-42) **Energy performance contracting in Newfoundland public buildings.** Brett, T. (Johnston and Buchan, Ottawa, ON (Canada)). Mercy Hospital and Medical Center, Chicago, IL (USA). [1989]. (CONF-8803277–: Organizing and financing energy efficiency projects in public buildings, St. John's (Canada), 29 Mar 1988; MICROLOG–90-03771). In *Organizing and financing energy efficiency projects in public buildings: Proceedings of a seminar.* 45p. Source: PC Newfoundland Dept. of Mines, Geological Survey Branch, P.O. Box 4750, St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper addresses the desirability of implementing energy performance contracting (EPC) projects to increase energy efficiency in public buildings in Newfoundland. After a brief explanation and historical background of EPC in Canada, the paper estimates the potential for energy savings through this process for various types of public facilities in Newfoundland as $11,300,000 for 122 buildings. Discussed are a number of policy issues that need to be clarified or resolved before such operations can proceed, including the issue of competitive bidding, and compliance with the Public Tender Act. A list of public buildings, hospitals and nursing homes with total annual energy costs greater than $50,000, and school boards, other provincial agencies and municipalities with total annual energy costs greater than $100,000 are included. 5 tabs.

51071 (NME–90-03771, pp. 45-51) **Energy performance contracting: The Ontario Government experience.** Sud, Shiv (Ontario Ministry of Energy, Ottawa, ON (Canada)). Mercy Hospital and Medical Center, Chicago, IL (USA). [1989]. (CONF-8803277–:

Organizing and financing energy efficiency projects in public buildings, St. John's (Canada), 29 Mar 1988; MICROLOG–90-03771). In *Organizing and financing energy efficiency projects in public buildings: Proceedings of a seminar.* 45p. Source: PC Newfoundland Dept. of Mines, Geological Survey Branch, P.O. Box 4750, St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Since 1975, the Ontario government has pursued aggressively energy efficiency improvements in its buildings, with cumulative energy savings of $450 million as of 1995. Due to limited capital budgets, The decision was made to experiment with the energy performance contracting (EPC) option. EPC is an arrangement in which a company provides an energy user with a comprehensive package of services (design, engineering, training, monitoring, financial, etc.) associated with the implementation of an energy management program. The user makes no capital payment for the project, and the company is reimbursed for its services from savings generated by the venture. This paper describes the on EPC project, the process followed in tendering and selecting an energy service company, and some suggestions on how other public sector organizations considering EPC for their buildings may benefit. The demonstration site chosen was the Ministry of Transportation complex in Downsview, Ontario, consisting of 16 buildings between 35 and 40 years old, using mainly natural gas and electricity with some back-up oil for heating. The overall benefits to the Ontario government included a total savings of $1.3 - 2.7 million over 10 years, no capital outlay, reversion of the equipment to the government after 7 years, and new technology, permitting accurate monitoring of the operation and precise control of the equipment.

51072 (OME–CE03182) **The advanced house.** Ontario Ministry of Energy, Toronto, ON (Canada). [1990]. 49p. (CE–03182). Source: Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST.

The Advanced House is Canada's most recent demonstration of leading edge residential energy-efficiency. The project objectives are to demonstrate new energy saving technologies and equipment, and to assess their potential for significant reductions in total home energy use and electrical peak load. Features include: high-performance windows, integrated mechanical system, energy-efficient appliances and lighting, high levels of insulation, airtight construction, two-storey passive solar sun space, and an energy-efficient fireplace; detailed descriptions of each are provided. The Advanced House is predicted to consume under 12,000 kWh a year for all its energy uses. An R-2000 house of the same design would require 28,000 kWh a year and a house built to the Ontario Building Code would use 41,000 kWh a year. Two years of detailed monitoring will confirm whether or not the house is meeting the energy target, and will identify any problems in the integrated mechanical system. Energy savings translate into reduced greenhouse gas emissions and reduced pollution. 19 figs.

51073 (PNL–7465) **Thermostat related behavior and internal temperatures based on measured data in residences.** Conner, C.C.; Lucas, R.L. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 49p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE91000582. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Building interior temperature is one of the major driving forces of energy use. Steady-state heat transfer for a building is a function of the temperature difference between inside and outside air, along with the conductance of the building shell. Changes of only a few degrees in interior temperatures can significantly affect energy use in buildings. This report examines the internal temperatures collected from a large set of residences in the Pacific Northwest for the Bonneville Power Administration (Bonneville) by Pacific Northwest Laboratory (PNL). Three large programs sponsored by Bonneville now provide a large dataset. the Residential Standards Demonstration Program (RSDP) measured the interior temperatures of about 800 buildings at approximate weekly intervals. About 300 homes were end-use metered and data were collected at 15-min intervals in the Hood River Conservation Project (HRCP) in Hood River, Oregon. The End-Use Load and Consumer Assessment Program (ELCAP) measured interior temperatures in about 400 buildings, including a subset of the RSDP buildings. Accurate thermostat set points and/or schedules are needed in simulation models to obtain reasonable estimates of energy usage. Simpler simulations often presume a constant thermostat set point. More complex simulations assume interior temperature set points, which often include temperature setbacks. 1 ref., 22 figs., 5 tabs.

51074 (PNL-SA–17701) **Miscellaneous equipment in commercial buildings: The inventory, utilization, and consumption by equipment type.** Pratt, R.G.; Williamson, M.A.; Richman, E.E. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 14p. Sponsored by Bonneville Power Administration; U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-900833–12: ACEEE summer study on energy efficiency in buildings, Pacific Grove, CA (USA), 26 Aug - 1 sep 1990). Order Number DE91000152. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The nature of the miscellaneous equipment (devices other than permanently installed lighting and those used for space conditioning) in commercial buildings is diverse, comprising a wide variety of devices that are subject to varied patterns of use. This portion of the commercial load is frequently underestimated, and widely hypothesized to be growing. These properties make it a particularly difficult load to characterize for purposes of demand-side management. In the End-Use Load and Consumer Assessment Program (ELCAP), over 100 commercial sites in the Pacific Northwest have been metered at the end-use level for several years. Detailed inspections of the equipment in them have also been conducted. This paper describes how the ELCAP data have been used to estimate three fundamental properties of the various types of equipment in several classes of commercial buildings: (1) the installed capacity per unit floor area, (2) utilization of the equipment relative to the installed capacity, and (3) the resulting energy consumption by building type and for the Pacific Northwest commercial sector as a whole. Applications for the results include assessment of conservation potential, prediction of equipment loads from survey data, estimating equipment loads for energy audits, targeting of conservation technology development, and disaggregating building total or mixed end-use data. 4 tabs., refs.

51075 (PNL-SA–18422) **Energy-efficient building design and operation: The role of computer technology.** Brambley, M.R. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 4p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-900833–9: ACEEE summer study on energy efficiency in buildings, Pacific Grove, CA (USA), 26 Aug - 1 sep 1990). Order Number DE91000153. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Computer technology provides many opportunities to improve the energy performance of commercial buildings throughout the entire building life cycle. We are faced with developing those technologies to put the results of many years of buildings research into the hands of building owners, designers, and operators. This report discusses both the philosophical and technological aspect associated with this topic.

51076 (PNL-SA–18447) **The integration of water loop heat pump and building structural thermal storage systems.** Marseille, T.J.; Schliesing, J.S. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-900833–10: ACEEE summer study on energy efficiency in buildings, Pacific Grove, CA (USA), 26 Aug - 1 sep 1990). Order Number DE91000151. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Commercial buildings often have extensive periods where one space needs cooling and another heating. Even more common is the need for heating during one part of the day and cooling during another in the same spaces. If a building's heating and cooling system could be integrated with the building's structural mass such that the mass can be used to collect, store, and deliver energy, significant energy might be saved. Computer models were developed to simulate this interaction for an existing office building in Seattle, Washington that has a decentralized water-source heat

pump system. Metered data available for the building was used to calibrate a "base" building model (i.e., nonintegrated) prior to simulation of the integrated system. In the simulated integration strategy a secondary water loop was manifolded to the main HVAC hydronic loop. tubing in this loop was embedded in the building's concrete floor slabs. Water was routed to this loop by a controller to charge or discharge thermal energy to and from the slabs. The slabs were also in thermal communication with the conditioned spaces. Parametric studies of the building model, using weather data for five other cities in addition to Seattle, predicted that energy can be saved on cooling dominated days. On hot, dry days and during the night the cooling tower can beneficially be used as a "free cooling" source for thermally "charging" the floor slabs using cooled water. Through the development of an adaptive/predictive control strategy, annual HVAC energy savings as large as 30% appear to be possible in certain climates. 8 refs., 13 figs.

51077 (QMER/BEEN–90-04349) **Energy efficiency in places of worship: Technical guide.** Parisel, C. Quebec Ministere de l'Energie et des Ressources, PQ (Canada). Bureau de t'Efficacite Energetique. Oct 1988. 78p. (MICROLOG–90-04349). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is intended to help to reduce the energy consumption of places of worship. The architecture of such buildings is substantially different from that of residential buildings. The focus of the report is on the retrofitting of existing buildings, within the limits imposed by the preservation of their architectural character. The gathering of information on the building itself and the identification of opportunities for energy savings are discussed. Practical information is given on how to improve the energy balance of the building through a variety of means: control of air infiltration, improvement of thermal insulation and the heating system, control of thermal stratification in naves, and reduction and improvement of lighting. In each case, indications are given as to how to estimate the potential energy savings and the profitability of each modification. 20 figs., 15 tabs.

51078 (QMER/BEEN–90-04350) **Energy efficiency in office buildings and commercial buildings: Manager's guide.** Quebec Ministere de l'Energie et des Ressources, PQ (Canada). Bureau de t'Efficacite Energetique. 1989. 162p. Translated and adapted from Energy managment for building and facilities: Energy efficient opportunities. (MICROLOG–90-04350). Source: PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This guide is intended for management personnel of commercial and office buildings who are already acquainted with energy conservation techniques. It gives an overview of current energy management techniques and of their possible applications to energy conservation. The subject, the various elements involved in energy management also are discussed: envelope of the building, operation and maintenance, heating systems, domestic hot water, cooling systems and heat pumps, air conditioning and ventilation systems, lighting systems, and automation. On each subject, a check-list of the possible energy savings is provided. A separate chapter deals with the currently debated question of air quality and its reaction to energy management. A bibliography on energy management and energy conservation is provided. 59 refs., 55 figs., 12 tabs.

51079 (QU–CE03093) **Exterior insulation, high rise retrofit: John Orr Tower [at] Queen's University.** Queen's Univ., Kingston, ON (Canada). May 1983. 33p. (CE–03093). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This interim report concerns the retrofitting of John Orr Tower at Queen's University. The tower is a 16 storey structure built in a 170 ft. maltese cross configuration containing 125 1-bedroom units. The project involved correcting three problems hindering proper use of the building: high energy consumption (487 kWh/m^2/y); water leaking through walls at construction joints; and windows leaking from rain blow through near the rain tracks. Problems were solved by: re-cladding the building with 3 in. of extruded polystyrene insulation to correct the heat loss problem; installing corrugated, painted, steel siding to act as a rain screen; and modifying windows by adding an airfoil at the base of windows to reverse the effect of the velocity pressure of the wind. The total energy consumption, electrical and steam, has been monitored for the past six years and will be continued for at least one more year. 18 figs.

51080 (SERI/TP–254-3800) **Desiccant contamination in desiccant cooling systems.** Pesaran, A.A. Solar Energy Research Inst., Golden, CO (USA). Aug 1990. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-901109–20: International symposium on gas-liquid two-phase flows in conjunction with the winter annual meeting of the American Society of Mechanical Engineers, Dallas, TX (USA), 25-30 Nov 1990). Order Number DE90000349. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper presents the results of a desiccant contamination experiment and the impact of the obtained silica gel degradation data on the performance of a desiccant cooling system. A test apparatus was used to thermally cycle several desiccant samples and expose them to "ambient" humid air or "contaminated" humid air. The source of contamination was cigarette smoke. The exposed desiccant samples were removed after 0.5, 1, 2, or 4 months of exposure and their moisture capacities were measured. The silica gel samples thermally cycled with ambient air showed a 5% to 30% to 70% of their moisture capacity. Using the obtained degradation data in a system, the impact of desiccant degradation on the performance of a desiccant cooling cycle was estimated. Depending on the degree of desiccant degradation, the decrease in thermal coefficient of performance (COP) and cooling capacity of the system was 10% to 35%. It was found that the COP and the cooling capacity of a system after desiccant degradation can be improved by increasing the rotational speed of the dehumidifier. This indicates that a simple engineering solution may exist to alleviate some type of degradations. 9 refs., 6 figs., 2 tabs.

51081 **A new approach to buildings and energy analysis.** Brodrick, J.R. (Gas Research Institute, Chicago, IL (US)); Crawley, D.B.; Briggs, R.S. *ASHRAE Journal (American Society of Heating, Refrigerating and Air-Conditioning Engineers) (USA),* 32(8): 15-20 (Aug 1990).

Traditionally, researchers have categorized the building stock for energy studies by grouping buildings according to their type, size and climate. This method has been useful but, because of the lack of statistical linkage to the population of office buildings, much uncertainty remains. In addition, other characteristics besides building type, size and climate significantly influence energy use. Among these are building form, glass amount, construction type, lighting power density and HVAC system type. These latter characteristics often have greater impact on building energy use than do building size and climate. A more accurate way to study office building energy use is to base categories on a more complete set of energy-related characteristics, instead of relying on only the physical features as has been done in previous studies. This article describes a new approach to categorizing the existing office building sector based on statistical techniques coupled with available databases on office buildings.

51082 **Seismic isolation systems with distinct multiple frequencies.** Wu, T.S.; Seidensticker, R.W. To Dept. of Energy, Washington, DC (USA). USA Patent 4,938,633/A/. 3 Jul 1990. Filed date 14 Apr 1989. USA Patent patents application 7-339,457. Int. Cl. E04H 9/02. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a method for supporting a structure such that it is isolated from seismic vibratory ground motion. It comprises: supporting the structure by a horizontal upper mat; providing a lower mat vertically adjacent to the upper mat of the structure that can support the structure; creating a structure and support system that has a characteristic frequency that is outside the range of expected frequencies of seismic vibratory motion by

coupling the upper and lower mats rigidly with primary isolator bearings, and altering the characteristic frequency of the structure and support system by coupling secondary isolator bearings rigidly to one of the upper or lower mats and movably to the other of the upper or lower mats to engage and disengage the secondary isolator bearing and the other mat in response to seismic vibratory motion.

3202 Transportation

Refer also to citation(s) 52498

51083 (DOE/BP–1347) **Research projects in industrial technology.** USDOE Bonneville Power Administration, Portland, OR (USA). Industrial Technology Section. Jun 1990. 35p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000202. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this booklet is to briefly describe ongoing and completed projects being carried out by Bonneville Power Administration's (BPA) Industrial Technology Section. In the Pacific Northwest, the industrial sector is the largest of the four consuming sectors. It accounted for thirty-nine percent of the total firm demand in the region in 1987. It is not easy to asses the conservation potential in the industrial sector. Recognizing this, the Northwest Power Planning Council established an objective to gain information on the size, cost, and availability of the conservation resource in the industrial sector, as well as other sectors, in its 1986 Power Plan. Specifically, the Council recommended that BPA "operate a research and development program in conjunction with industry to determine the potential costs and savings from efficiency improvements in industrial processes which apply to a wide array of industrial firms." The section, composed of multidisciplinary engineers, provides technical support to the Industrial Programs Branch by designing and carrying out research relating to energy conservation in the industrial sector. The projects contained in this booklet are arranged by sector –industrial, utility, and agricultural – and, within each sector, chronologically from ongoing to completed, with those projects completed most recently falling first. For each project the following information is given: its objective approach, key findings, cost, and contact person. Completed projects also include the date of completion, a report title, and report number.

51084 (PB–90-252305/XAB) **Industry perspective on Maglev. Final report.** Federal Railroad Administration, Washington, DC (USA). Office of Research and Development. Jun 1990. 27p. (DOT/FRA/ORD–90/07). Source: NTIS, PC A03/MF A01.

Most of the recent discussion and proposed legislation concerning Maglev assumes that U.S. industry has a strong interest in Maglev and will be willing to take a proactive, cost-sharing role in the development of Maglev systems. As part of the preliminary feasibility studies on Maglev, the Federal Railroad Administration obtained the perceptions of several major U.S. corporations and identified their interest in a Maglev program, their willingness to participate, and any potential barriers to their participation. The industry perspectives were obtained through an independent and unbiased external study that included in-depth interviews with senior executives from 22 major U.S. corporations. The study, conducted during April and May 1990, was primarily directed at the development and implementation of a next-generation leapfrog Maglev system in the United States. It was not aimed at assessing the interests of individual entrepreneurs in implementing existing German (or Japanese) systems.

51085 (PB–90-255654/XAB) **Implementation of a mezzo-level HOV carpool model for Texas. Final report, September 1986-April 1990.** Benson, J.D.; Mullins, J.A.; Stokes, R.W. Texas A and M Univ., College Station, TX (USA). Texas Transportation Inst. Nov 1989. 71p. (TTI–2-10-87-1103-2F). Source: NTIS, PC A04/MF A01.

The report presents the results of an evaluation and adaptation of three existing high-occupancy vehicle (HOV) lane carpool demand estimation models for possible use in Houston and other large Texas cities. These models use trip tables, networks and zone structures that are consistent with the regional travel demand modeling process currently in use in Texas. By implementing the HOV carpool models in a structure that is consistent with the regional travel demand modeling process, it is possible to estimate the carpool demand for an HOV facility and to evaluate the effects of the following changes in HOV lane configuration and operating strategies: (1) Effects of additional and/or alternative access points; (2) Effects of extending and HOV lane; and (3) Effects of changing the definition of eligible HOV carpools. The models have produced promising results in test applications in Houston.

51086 (TP–9877E) **Passenger car fleet fuel consumption estimation program: Examples of use.** Transport Canada, Ottawa, ON (Canada). Road Safety. Mar 1989. 57p. (MICROLOG–90-04491). Source: PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The passenger car fleet fuel consumption estimation program allows the user to determine, with ease, the effect of changes in vehicle parameters, usage and operating speed characteristics, both individually and in combination with each other. The examples discussed in this report illustrate the wide range of applications in which the program can be used and the order of fuel savings which result. Data for the 1987 passenger car fleet is used and realistic estimates of on-road fuel savings are given. The program does not, however, model the effect of cold starts, due to lack of reliable data, which results in estimates being, on average, 10% less than on-road values. The program should prove to be a valuable tool for road transport and energy planners and administrators to predict future trends in passenger car fleet fuel consumption and assess the long term effect of changes in vehicle parameters, usage and operating speeds. 10 refs., 16 figs., 1 tab.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 50449, 50481, 50734, 50759, 50907, 50994, 51014, 51029, 51080, 51098, 51666

51087 (BCC–CE03190, pp. 55-66) **Recycling in the pulp and paper industry.** Soulsby, J. Boise Cascade Canada Ltd., Newcastle, NB (Canada). 1990. (CONF-9001116–: 22. annual Lakehead University Forestry Association forestry symposium, Thunder Bay (Canada), Jan 1990; CE–03190). In *Resource rich/development poor. An overview of forest products industries in Canada.* 92p. Source: School of Education, Lakehead University, Thunder Bay, ON, CAN P7B 5E1. Prices: PRICES UPON REQUEST.

Of the 143 pulp, paper, and paperboard mills in Canada, 40 are using recyclable waste paper; in 1988, these mills recycled about 1.8 million tonnes of waste paper. Some of these mills have been practising recycling as far back as the 1920s. Almost a third of this recycled material was imported from the USA, but it is expected that as a result of increasing waste paper collection in Canada imports will probably drop 8-9% next year. The types of waste paper are described, including container grades, high grade deinkings and pulp substitutes, news grades, and mixed papers. The processing of waste paper is a specialized branch of papermaking, requiring processes and equipment of unique design for repulping, cleaning, contaminant removal, and in some cases deinking. The product to be made will largely determine the grades of waste paper that can be used. If product quality is to be maintained at reasonable levels, a certain amount of virgin fiber will always be required, since there is a limit to the number of times the same cellulose fiber can be recycled. The implications of this fact for solid waste disposal are discussed, along with the impacts of waste paper recycling legislation on the industry. It is noted that long lead times and significant investment costs mean that production of paper made from recycled products will lag behind demand for such paper for some time. In Canada, some new waste paper recycling projects have been announced and five of these are outlined. At present, most grades of waste paper are in adequate or excess supply, but most will be in short supply by the mid-1990s. This will come about as a result of increased domestic demand coupled with rising demands from areas lacking in indigenous fiber resources. 2 figs.

51088 (CONF-900801–28) **An energy-conserving process to treat and recycle wastewater and sludges.** Jody, B.J.; Daniels, E.J. Argonne National Lab., IL (USA). May 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90017671. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes a process that combines the energy-conserving features of a multiple effect evaporator with a chemical reactor to treat wastewater and sludges containing heavy metals, suspended solids, and organic compounds. Temperatures and pressures can be controlled such that the organic species can be made to evaporate with the steam, which could be superheated to promote the destruction of the organic species via hydrolysis and thermal decomposition. The product stream can be passed over a catalyst bed where a reagent such as oxygen, ozone, or hydrogen can be introduced to clean up the product stream further. As a result, the residual (thickened) wastewater or sludge is reduced in mass and volume. The treatment of its heavy-metals content will thus be less expensive. The process employs a combination of commercially available equipment. The evaporator may require a slight modification to be able to handle sludges containing high levels of solids. The process runs continuously and requires minimal human interaction. 1 fig.

51089 (DPAG–68-2/1-1OE) **A report on the international fisheries energy optimization workshop, Aug. 28-30, 1989, University of British Columbia, Vancouver, B.C.** General education series, No. 10. Buxton, R.; Robertson, D. DPA Group, Inc., Calgary, AB (Canada). 1989. 42p. (MICROLOG–90-04864). Source: PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A workshop was held to share information on optimizing energy use in the fishing industry and to identify opportunities for international cooperation in this area. A summary of this workshop is presented. Energy optimization was considered as part of energy policy, resource management, vessel/gear design and modification, and vessel operation. Specific problems and opportunities discussed were the influencing of energy policymakers, making the most effective use of modern technology (especially computers), disseminating information, and monitoring and evaluating new technology. Papers were presented at the workshop on such topics as harvesting technologies, fishing vessel design and development, and technology transfer. Areas needing further research and development were identified. Future directions for the energy optimization working group were also discussed and are summarized.

51090 (FSC–CE03107) **Fort Providence waste heat recovery.** Ferguson, Simek, Clark Ltd., Yellowknife, NT (Canada). [1980]. 24p. (CE–03107). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report was commissioned by Northwest Territories (N.W.T.)/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA) to provide the results of the experience gained and guidance for the replication of a unique energy supply and conservation system in Fort Providence, N.W.T. Savings of $2,500 per month were realized on a total capital outlay of $50,000 (not including the considerable time spent by the owner). To achieve this pay-back in less than two years the owner designed the entire system and, over a ten year period, has developed one of the most advanced diesel generator/heat recovery/district heating/radiant floor energy efficient building systems in existence. The owner successfully applied to CREDA in 1980 to further enhance this sophisticated yet reliable operation by the addition of a wood waste gasifier to fuel a diesel generator. The experience of this project is reported separately (CREDA NWT Project #1). 18 figs.

51091 (KCP–613-4437) **Deburring and surface finishing: The past ten years and projections for the next ten years.** Gillespie, L.K. Allied-Signal, Inc., Kansas City, MO (USA). Bendix Kansas City Div. Sep 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. (CONF-9010203–1: Deburring salon conference, Nagoya (Japan), 23-25 Oct 1990). Order Number DE91000579. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The 1970s were a decade of significant growth in deburring and surface finishing. In the 1980s progress was made in robotic finishing, burr formation models, surface finish measurement, new processes, equipment and tooling. The centers of burr and surface related research changed. The decade of the 1990s will bring greater competition, environmental restrictions, more processes, more automation, and better characterization and simulation of processes.

51092 (MIC–90-03969/XAB) **Development of an economic large-scale growth medium for Rhizopus arrhizus, a uranium-adsorbing fungus. Final report.** Lakshmanan, V.I.; Tackaberry, P. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). ©1989. 55p. Contract CANMET-89198-01-SQ. Source: NTIS, PC EE07/MF E01.

Fungal biomass is capable of removing uranium from solution and as such has the potential to become incorporated into a processing flow sheet for recovering uranium from dilute mine waters. Producing the biomass for uranium-adsorption has usually depended on a commercially available growth medium, introducing the potential for increased processing costs. With the availability of a wide variety of industrial based food waste, the project investigated the possibility of maximizing the biomass harvest using food waste as the growth medium. This program uses the proven uranium-adsorbing fungus Rhizopus arrhizus to develop an economic alternative growth substrate that will support the maximum biomass harvest as well as maintain high uranium-adsorption values.

51093 (ORNL/FTR–3722) **[Acceptance testing of the 150-kW electron-beam furnace]: Foreign trip report, August 11–18, 1990.** Ohriner, E.K.; Howell, C.R. Oak Ridge National Lab., TN (USA). 18 Sep 1990. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE91000385. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The travelers observed the acceptance testing of the 150-kW electron-beam (EB) furnace constructed by Leybold (Hanau) Technologies prior to disassembly and shipping. The testing included: (1) operation of the mold withdrawal system (2) vacuum pumping and vacuum chamber leak-up rates, (3) power stability at full power, (4) x-radiation monitoring at full power, and (5) demonstration of system interlocks for loss of water cooling, loss of vacuum, loss of power, and emergency shutdown. Preliminary training was obtained in furnace operation, EB gun maintenance, and use of the programmable logic controller for beam manipulation. Additional information was obtained on water-cooling requirements and furnace platform construction necessary for the installation. The information gained and training received will greatly assist in minimizing the installation and startup operation costs of the furnace.

51094 (PB–90-258518/XAB) **Effect of recycling thermophilic sludge on the activated-sludge process. Report for October 1984-June 1989.** Prakasam, T.B.S.; Soszynski, S.; Zenz, D.R.; Lue-Hing, C.; Blyth, L. Metropolitan Water Reclamation District of Greater Chicago, IL (USA). 1990. 278p. Grant EPA-R-811925. Source: NTIS, PC A13/MF A02.

A full-scale investigation was undertaken at Chicago's Hanover Park Water Reclamation Plant (WRP) to study whether the net sludge production from the WRP could be reduced by implementing a scheme developed by W. Torpey et al. (1984). In this process, sludge is withdrawn from a thermophilic digester operated in series with a mesophilic digester and partially recycled into the aeration tanks of the activated sludge system. The Hanover Park WRP, which has a design flow capacity of 45,420 million cu m per day (12 mgd), was split into a control section and an experimental section. The two sections were operated similarly except the thermophilic drawoff was recycled into the aeration tanks of the experimental section from a digester system consisting of mesophilic and thermophilic digesters operated in series. A reduction in net sludge production of about 10 percent was achieved at 40 percent recycle of thermophilic sludge into the aeration tanks at the

Hanover Park WRP. This was a much smaller reduction than obtained by Torpey et al. Sludge dewatering properties were not improved. The recycling produced no adverse effects on quality of the treated wastewater.

51095 (STEV–1989-R21) **Pulp- and paper industry: Production technology and energy balance.** Poeyry, J. Statens Energiverk, Stockholm (Sweden). Dec 1989. 58p. (In Swedish). Order Number DE91707865. Source: NTIS (US Sales Only), PC A04/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The consumption of electric power within the Swedish pulp- and paper industry has increased considerably during later years. Most of the increase is tied to a change to mechanical pulp manufacturing processes, which demands more electricity than the chemical processes. By using back pressure power turbines the possible power production is 5 TWh/year, which is twice the amount of the production in 1988. At sulphate pulp production, spent liquors is a large internal energy source, which theoretically can produce 4 TWh/year of electric power. New boilers may increase this figure to 5.5 TWh by the year 2000. An alternative to the combustion of spent liquors is gasification, which early in the next century may yield 10.5 TWh/year. Gasification of wood fuels may theoretically produce approx 10 TWh/year providing the fuel price can be kept low. The production of pulp and paper is very sensitive to changes in the price on electricity. An increase with SEK 0.15/kWh will probably result in the closing down of two mechanical pulp factories and two newspaper-making machines by the year 2000. With an increase of SEK 0.50/kWh it is reasonable to suppose that all of the five mechanical pulp factories and most of the newspaper-making machines will be closed down in the year 2000. (U.W.).

51096 **Microwave heating apparatus and method.** Johnson, A.J.; Peterson, R.D.; Swanson, S.D. To Dept. of Energy, Washington, DC (USA). USA Patent 4,940,865/A/. 10 Jul 1990. Filed date 25 Oct 1988. USA Patent patents application 7-261,865. Int. Cl. H05B 6/80. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a microwave apparatus for heating materials. It comprises: a microwave energy input for delivering microwave energy, a resonant cavity for receiving microwave energy through the input, a microwave energy choke encompassing the floor opening of the resonant cavity, a microwave energy reflective container for holding the materials to be heated, turning the container during exposure of the materials in the container to microwave energy, located outside of the cavity, and means for lifting the container, located outside of the cavity.

3206 Municipalities and Community Systems

Refer also to citation(s) 50731, 50751, 50891, 50907, 50912, 50913, 50993, 50996, 51002, 51026, 51066, 51087, 51088, 51670

51097 (BFR-R–47-1990) **Distribution nets for distric heating: An overview and status report.** Abrahamsson, B. (Fjaerrvaermebyraan AB, Vaesteraas (SE)). Swedish Council for Building Research, Stockholm (Sweden). 1989. 21p. (In Swedish). Project BFR-880686-6. Order Number DE91707890. Source: NTIS (US Sales Only), PC A03/MF A01.

The future investment requirements and costs for maintenance, repair and renewal of the swedish district heating networks are estimated. The report is based on statistical material containing information on total length, conduit types, pipe dimensions and age of the swedish district heating systems. Use has also been made of the reported failures during a 29 year period, and the failure rate classified according to the age of the installations. (L.E.).

51098 (SEU–1) **Technical means for load management.** Svensk Energi Utveckling AB, Stockholm (Sweden); Sydkraft AB, Malmoe (Sweden). 1989. 279p. (In Swedish). Order Number DE91707841. Source: NTIS (US Sales Only), PC A13/MF A01.

Field experiments have been made to test different means for electric load management in some user sectors. Technical equipment for both direct and indirect load management was used in pilot studies in industry, for space heating of houses and office buildings, and for large bivalent heat pump systems. The technical systems were designed to reduce the inconveniences for the customers as much as possible. The results have been analyzed with the relation power distributor - customer in focus. Later, a study of the effects for the complete system power producer - distributor - customer will be published. There methods were applied for the industry customers: power interrupts, priority ranking of loads, and time displacements of load. For the space heating studies, time displacements of load and variable highest power level were the principles used. (L.E.).

51099 (TES–CE03099) **LeBreton Flats district heating: Construction report: Demonstration report.** TES Ltd., Ottawa, ON (Canada). Jan 1982. 40p. (CE–03099). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The concept of distributing heat from a central plant to buildings through underground piping has existed in Canada for many years. These district heating systems generally have served a small number of non-residential users. TES Limited was contracted by Canada Mortage and Housing Corporation (CMHC) to prepare a report on the construction of the LeBreton Flats District Heating System. The intent of this report is to provide a concise overview of the system for a general audience. The components used in the district heating project are listed, along with the various contractors. Construction and installation of the equipment is detailed. Unique features in the LeBreton project are highlighted, and compared to typical European and North American system practices. As well, the problems encountered in the construction of the system are discussed. An interim performance evaluation report was scheduled for Febuary 1983, followed by a final system evaluation in March, 1984. 7 figs., 3 tabs.

51100 (TES–CE03100) **LeBreton Flats district heating: Design report.** TES Ltd., Ottawa, ON (Canada). [1981]. 51p. (CE–03100). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

An overview of the LeBreton Flats District Heating Project in Ottawa is presented. The report outlines the background of the project, reviews the district heating concept and how European style concepts were incorporated in this project. A detailed description of system components and design parameters includes the plant, buried distribution system and equipment internal to buildings. Emphasis has been placed on providing the reader with a global picture of the various design issues that were encountered during the planning of the project. More detailed information, including drawings and specifications for the system, is available on request from Canada Mortgage and Housing Corporation or the Ministry of Energy (Ontario). The report is structured to provide background on some of the design issues that are involved in adapting European district heating methods to Canadian needs, and to introduce certain complexities unique to LeBreton Flats. A brief overview of the numerous engineering and utility criteria is given, followed by a detailed discussion of the different components of the district heating system. The report also outlines the monitoring program that will be used to investigate the performance of the system. 14 figs., 4 tabs.

3209 Education and Public Relations

51101 (MEM–9(80-16)) **Energy management course for building managers.** Manitoba Dept. of Energy and Mines, Winnipeg, MB (Canada). Apr 1984. vp. (CE–03108). Source: CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The training of building managers/operators to become energy conscious can be one of the most cost effective ways of saving energy and money. To this end a pilot course in energy management was developed by a task force composed of members from various government agencies. The course covered a number of subjects concerned with energy conservation in building operations and systems design. Course progress was monitored by an ad hoc

committee. An attempt to judge the effectiveness of course training was made by comparing energy consumption in two of the government buildings before and after the operators had participated in the course. Significant savings of energy and money were reported, however, the actual portions attributable to course training could not be reasonably estimated. Several problems were common to both the pilot and public presentations. Chief among these was an over-emphasis of background material on principles of building operation, which resulted in superficial treatment of energy management concepts. Lack of definition of course goals, a result of inadequate communication between the operators and their supervisors, contributed to attitude problems with some of the course participants. While the merit of the concept was demonstrated (participants reported increased awareness of energy conservation), overall the course was judged to be unsuccessful in meeting the potential for such instruction. Most operators did not acquire the skills required to properly implement energy management in their buildings. A number of recommendations for improvement of the course are made. 2 refs., 2 figs.

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 50755

51102 (AD-A–223033/2/XAB) **Electrostatic fuel atomization and spray-dispersal demonstration. Final report, September 1989-January 1990.** Kelly, A.J. ZWY Corp., Princeton Junction, NJ (USA). Jul 1990. 36p. Contract F33615-89-C-2937. (ZYW–0001Z). Source: NTIS, PC A03/MF A01.

The purpose of this work is to characterize charged spray plumes, test the validity of existing spray/plume models, provide a basis for evaluating these plumes for gas turbine fuel and ignitor systems service. Plumes generated by a charge injection atomizer in nitrogen (< or = bar, absolute) have been analyzed using an Aerometrics Phase Doppler Particle Analyzer (PDPA). A 10 bar the outer, small droplet sheath is characterized by a Sauter mean diameter (D32) of about 55 microns, a span of about 0.7 and a number median of about 20 microns. The inner, large droplet core is characterized by D32 about = 110 microns and the same span. These data conform to a predicted overall droplet size distribution exhibiting a polydispersed profile: primary peak at about 105 microns, and secondary peaks at about 85 and 135 microns. The peaks are associated with the core region; the near constant profile below about 85 microns is characteristic of the sheath. Contrary to prediction, D32 increased modestly with pressure in these tests due to two factors: output charge density levels remained fixed with increasing pressure due to shortening of the sprayer caused by droplets stagnating in the test chamber; and, the predictable, lateral plume core expansion to the probe sampling position. A modest air flow over the spray unit corrects these problems.

51103 (CONF-9009113–1) **Cylinder pressure analysis of a diesel engine using oxygen-enriched air and emulsified fuels.** Sekar, R.R. (Argonne National Lab., IL (USA)); Murr, W.W. Cole, R.L.; Marcihiak, T.J.; Schaus, J.E.; Eustis, J.N. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From SAE international off-highway and power plant congress and exposition; Milwaukee, WI (USA); 10-13 Sep 1990. Order Number DE90017660. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Analytical studies of oxygen-enriched diesel engine combustion have indicated the various benefits as well as the need for using cheaper fuels with water addition. To verify analytical results, a series of single-cylinder diesel engine tests were conducted to investigate the concepts of oxygen enriched air (OEA) for combustion with water emulsified fuels. Cylinder pressure traces were obtained for inlet oxygen levels of 21% to 35% and fuel emulsions with water contents of 0% to 20%. Data for emulsified fuels included No. 2 and No. 4 diesel fuels. The excess oxygen for the tests was supplied from compressed bottled oxygen connected to the intake manifold. The cylinder pressure data was collected with an AVL pressure transducer and a personal computer-based data logging system. The crank angle was measured with an optical encoder. In each data run, 30 consecutive cycles were recorded and later averaged for analysis. The data analysis was done with a heat release analysis code written for a personal computer. The results indicate that water emulsified fuels consistently gave a slight improvement in thermal efficiency and a greater portion of the fuel energy was released in the early part of the combustion process compared with base fuels. OEA reduced the ignition delay and measurably changed the shape of the calculated heat release rate and cumulative heat release diagrams. Comparative cylinder gas temperatures, computed from measured cylinder pressures, are presented in an effort to explain changes observed in the emissions of nitrogen oxides (NO_x), smoke, and particulate matters. The data indicates that smoke and particulate emissions decrease and NO_x increases when intake O_2 level is increased. 12 refs., 15 figs., 2 tabs.

51104 (CONF-9010193–3) **Low heat rejection diesel ceramic coupon tests.** Brinkman, C.R.; Liu, K.C.; Graves, R.L.; West, B.H. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual automotive technology development contractor coordination meeting; Dearborn, MI (USA); 22-25 Oct 1990. Order Number DE91000737. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results are reported from studies in which several monolithic ceramic materials in the form of modulus-of-rupture bars were exposed for 100 h to the combustion conditions found in either a small single- or two-cylinder diesel engine. Fuels included a standard Phillips D-2 diesel or synthetic mixture of the Phillips D-2 and an aromatic blend. The ceramics included two commercial grades of partially stabilized zirconia: (1) PSZ-TS and (2) PSZ-MS and silicon nitride (GTE WESGO SNW-1000 and Norton NT-154). Significant reductions in postexposure four-point bend fracture strength occurred in the PSZ-TS material irrespective of whether it was exposed in the single- or two-cylinder engine. Only a small decrease in fracture strength occurred in the PSZ-MS material, and essentially no decrease in fracture strength occurred in the silicon nitride (GTE WESGO SNW-1000) when tested at room temperature. The Norton NT-154 silicon nitride was tested at both room temperature and at 700°C over several strain rates ranging from 1×10^{-4} to $1 \times 10^{-7} S^{-1}$. Room temperature tests showed that the engine exposed bars actually showed a slight increase in average strength, 830 MPa, versus 771 MPa for the unexposed material. 6 figs., 1 tab.

51105 (DOE/MC/23167–2874) **Advanced coal-fueled gas turbine systems: Quarterly report, January–March 1990.** Westinghouse Electric Corp., Orlando, FL (USA). Power Generation Projects Div. Jun 1990. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23167. Order Number DE90009695. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Work continued on coal-fueled gas turbine systems. This quarter, subscale slagging combustor testing was temporarily concluded with a series of coal-water mixture (CWM) tests during this quarterly reporting period. It will be resumed when a new slag trap assembly and a new slagging cyclone separator are received from vendors. A relatively low-sulfur (1.04 percent) coal, Dorchester, was sued during a series of sulfur-capture tests with various sorbents. A high-sulfur coal, Pittsburgh No. 8, (2.39 percent) was evaluated for combustion characteristics only. During this period, the hot flow rig came on line at ARL's Haverhill facility. This does not replicate the complete engine system in small size, but rather models sulfur capture at high temperature. The greater part of the activity during this period was taken up with an extensive shakedown process. 11 figs., 5 tabs.

51106 (DOE/MC/23174–2844) **Coal fueled diesel locomotive conceptual system economic analysis.** General Electric Co., Erie, PA (USA). Transportation Systems Business Div. Sep 1989. 50p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-88MC23174. Order Number DE90009657. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The design of a coal fueled diesel locomotive is described. Discussions on engine design, fuel injection system, economic analysis, and exhaust gas control are included. 18 refs., 42 figs., 77 tabs. (CBS)

3302 External Combustion Engines

51107 (DLR-Mitt.–90-03) **Performance measurements and energy balance of an SPS V 160 Stirling motor at the German Aerospace Research Establishment.** Noyes, G. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik). Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany, F.R.). 1990. 30p. Order Number DE91712431. Source: NTIS (US Sales Only), PC A03/MF A01.

Before conversion to solar operation to serve as a solar receiver test bed a Stirling Power Systems V160F natural gas-fired cogeneration stirling motor was tested. A test stand was built and instrumented and the motor performance was measured under various loads. An energy balance of the motor/generator unit was done including electric output and input, thermal input, waste heat in the cooling water, cooling air, exhaust, radiation and free convection from the motor housing. The influence of the internal cooling water temperature on motor performance was measured. Measurements, including an exhaust gas analysis and surface temperature distribution, were made to determine the combustion chamber efficiency. A magnetic eddy current brake was used to measure the shaft output of the stirling motor and measure the efficiency of the generator. The total natural gas to electric energy conversion efficiency was measured to be 23% above of full power, 20% efficiency was achieved down to 1/3 power. Maximum power was measured at 8.9 kWe. (orig.) With 13 figs., 8 refs.

3303 Electric-Powered Systems

Refer also to citation(s) 50916

51108 (LA-UR–90-3356) **Advanced system analysis for indirect methanol fuel cell power plants for transportation applications.** Vanderborgh, N.E.; McFarland, R.D.; Huff, J.R. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. (CONF-901106–1: Fuel cell seminar, Phoenix, AZ (USA), 26-28 Nov 1990). Order Number DE91000171. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The indirect methanol cell fuel concept actively pursued by the USDOE and General Motors Corporation proposes the development of an "electrochemical engine" (e.c.e.), an electrical generator capable for usually efficient and clean power production from methanol fuel for the transportation sector. This on-board generator works in consort with batteries to provide electrical power to drive propulsion motors for a range of electric vehicles. Success in this technology could do much to improve impacted environmental areas and to convert part of the transportation fleet to natural gas- and coal-derived methanol as the fuel source. These developments parallel work in Europe and Japan where various fuel cell powered vehicles, often fueled with tanked or hydride hydrogen, are under active development. Transportation applications present design challenges that are distinctly different from utility requirements, the thrust of most of previous fuel cell programs. In both cases, high conversion efficiency (fuel to electricity) is essential. However, transportation requirements dictate as well designs for high power densities, rapid transients including short times for system start up, and consumer safety. The e.c.e. system is formed from four interacting components: (1) the fuel processor; (2) the fuel cell stack; (3) the air compression and decompression device; and (4) the condensing cross flow heat exchange device. 2 figs.

51109 (UBA-FB–89-062) **Development and testing of electrical 'Leichtmofas'/'Mofas'.** Naunin, D. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Elektronik); Gutekunst, K.; Klug, R.; Thieler. Umweltbundesamt, Berlin (Germany, F.R.); Nuernberger Hercules-Werke GmbH, Nuernberg (Germany, F.R.); Sachs Systemtechnik GmbH, Schweinfurt (Germany, F.R.); Technische Univ. Berlin (Germany, F.R.). Inst. fuer Elektronik. Apr 1988. 180p. (In German). Contract UFOPLAN-Nr. 10505132/02. Source: Copy held by UB/TIB Hannover.

The environmental noise and the air pollution, caused by the individual traffic in the town centers, is extremely high. As an alternative to motorized bicycles with combustion engines two- or three-wheeled vehicles powerd by electromotors are designed, constructed and evaluated in their behaviour in this project. They have an appropriate motorization and adequate driving range and are easy to handle. All components are motor, gear, batteries, control, charging device, and chassis have been extensively optimised using the newest technolgies. These electric vehicles are a feasible choice for the local traffic and in view of comparable vehicles driven by combustion engines they can be preferably accepted by users, who are conscious of evironmental problems. (orig.) With 41 refs., 28 tabs., 40 digrams, 37 figs.

3304 Hybrid Systems

Refer also to citation(s) 50916

3307 Emission Control

Refer also to citation(s) 51106, 51330

51110 (PB–90-258971/XAB) **Laboratory evaluations of controlled combustion quenching and stratified exhaust-gas injection for NOx control on a four-stroke reciprocating engine. Topical report, May 1987-December 1988.** Thring, R.H. Southwest Research Inst., San Antonio, TX (USA). Dept. of Engine and Vehicle Research. Jun 1990. 66p. Contract GRI-5084-251-1101. (SWRI–03-1781-102). Source: NTIS, PC A04/MF A01.

The report describes laboratory evaluations of Controlled Combustion Quenching (CCQ) and Stratified Exhaust Gas Injection (SEGI), two new proposed techniques for NOx control in natural gas piston engines. With CCQ a quenching fluid is injected into the combustion chamber during the combustion process. CCQ showed NOx reductions of 60 to 85 percent, with relatively small penalties in fuel consumption (less than 8 percent) and other emissions. Another potential advantage of CCQ is that, unlike with conventional water injection, there seemed to be very little contamination of the lubricating oil. This fact suggests that CCQ may be applicable without causing engine durability degradation, such as has been feared for conventional water injection. Engine tests of stratified exhaust gas injection were not so promising in that, for a given flow rate of exhaust gas the stratified exhaust gas gave only half as much reduction in NOx as homogeneous exhaust gas recirculation. However, it is believed that the exhaust gas stratification was not optimally configured; that is, the exhaust gas cloud was located too far from the spark plug.

51111 (UBA-FB–89-135) **Trial of particulate traps for heavy duty vehicles with diesel engines. Final report.** Neppel, H.P. Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (Germany, F.R.); Umweltbundesamt, Berlin (Germany, F.R.). 1989. 254p. (In German). Contract UFOPLAN-Nr. 10405742. Source: Copy held by UB/TIB Hannover.

Five city buses and heavy duty trucks were equipped with different particulate traps and tested over a period of up to two years. The particulate traps were catalytic trap oxidisers without any special mean of regeneration and catalytic coated respectively uncoated ceramic monoliths. The regeneration was forced using either an oilburner, an electrical heating or by throttling the exhaust gas. In one case a coating was tested in order to decrease the ignition temperature of soot. For the exhaust emission measurement under instationary conditions a measuring technique was developed with proportional volume sampling. A ceramic trap with regeneration by oilburner fitted into a bus and one with electrical heating installed into a truck showed the best results. These both systems have been proved to be suitable in principle for fitting into vehicles in use. Therefore they will be developed and improved in the future. (orig.).

3308 Alternative Fuels

Refer also to citation(s) 51103, 51108

35 ARMS CONTROL

51112 (AD-A-223416/9/XAB) **Third World arms proliferation and forced-entry operations: Circumstances demanding the creation of a standing Joint Task Force headquarters. Individual study project.** Morgan, T.C. Army War Coll., Carlisle Barracks, PA (USA). 29 Mar 1990. 36p. Source: NTIS, PC A03/MF A01.

Secretary Cheney's 1990 Annual Report to the President and the Congress established the requirement for the Unified Commanders in Chief to be prepared for Third World conflict involving roles and missions requiring, mobile, highly ready, well equipped forces and solid power projection capabilities. While the Services have forces that are prepared to execute the forced entry missions, what is missing is a joint operational level headquarters to command these joint forced entries. Our joint history highlights two critical points in this area. First is that our task organization is routinely a hastily formed Joint Task Force (JTF). The second and more critical point is that the operational-level headquarters is normally an aggregation of individuals brought together at the last possible moment. This combination along with the authors experience in the Second Marine Division from 1984-1989 in both join training and contingency situations (Solid Shields, Ocean Ventures, Joint Supporting Arms coordination Exercises and in the initial deployments and planning for operations in Panama) led to the thesis that a CINC requires a trained, cohesive, joint headquarters with an in-depth understanding of current tactics and a joint operational, combined arms vision to plan and execute forced entry against a Third World nation that possesses air defense and antiship missiles and main battle tanks.

3501 Policy, Negotiations, and Legislation

51113 (AD-A-223345/0/XAB) **National policy, goals, and objectives after chemical disarmament. Study project.** Fahl, R.G. Army War Coll., Carlisle Barracks, PA (USA). 2 Apr 1990. 55p. Source: NTIS, PC A04/MF A01.

Since World War I, the United States has been in the forefront of peacekeeping nations in trying to ban the use of lethal weapons. Today, negotiations for a bilateral and multilateral Chemical Weapons Convention banning the development, production and use of chemical weapons and eliminating all stocks globally are closer to success than anytime in the past. In light of the ongoing negotiations on chemical disarmament, this paper reexamines current U.S. policy statements, elaborates on the full spectrum of possible threats, and enumerates U.S. vulnerabilities in light of the foregoing threat analysis.

51114 (ANL/ACTV-90/3) **Conventional armed forces in Europe: Technology scenario development.** Houser, G.M. Argonne National Lab., IL (USA). Jul 1990. 138p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-31109-ENG-38. Order Number DE91000097. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

In January 1986, the Soviet Union's Mikhail Gorbachev proposed elimination of all nuclear weapons by the year 2000. In April of that year, Mr. Gorbachev proposed substantial reductions of conventional weapons in Europe, from the Atlantic Ocean to the Ural Mountains, including reductions in operational-tactical nuclear weapons. In May 1986, the North Atlantic Treaty Organization (NATO) responded with the "Brussels Declaration on Conventional Arms Control," which indicated readiness to open East/West discussions on establishing a mandate for negotiating conventional arms control throughout Europe. The "Group of 23," which met in Vienna beginning in February 1987, concluded the meeting in January 1989 with a mandate for the Conventional Armed Forced in Europe (CFE) negotiations. On 6 March 1989, CFE talks began, and these talks have continued through six rounds (as of April 1990). Although US President George Bush, on 30 May 1989, called for agreement within six months to a year, and the Malta meeting of December 1989 called for completion of a CFE agreement by the end of 1990, much remains to be negotiated. This report provides three types of information. First, treaty provisions brought to the table by both sides are compared. Second, on the basis of these provisions, problem areas for each of the provision elements are postulated and possible scenarios for resolving these problem areas are developed. Third, the scenarios are used as requirements for tasks assigned program elements for possible US implementation of a CFE treaty. As progress is achieved during the negotiations, this report could be updated, as necessary, in each of the areas to provide a continuing systematic basis for program implementation and technology development. 8 refs.

3502 Proliferation

Refer also to citation(s) 51112

3503 Verification

51115 (LA-UR-90-3241) **ASA arms control session 1990.** Picard, R.R. Los Alamos National Lab., NM (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9008155-1: American Statistical Association (ASA) conference on statistics and national security, Anaheim, CA (USA), 6-8 Aug 1990). Order Number DE91000219. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. ARMS CONTROL; SAMPLING; TREATIES/verification; SAMPLING; TREATIES; VERIFICATION; MILITARY EQUIPMENT

36 MATERIALS

Refer also to citation(s) 50990, 52588

51116 (KFK-4650) **Materials research in the Nuclear Research Centre Karlsruhe. Report on 25 years' existence of the Institute for Material and Solids Research.** Kleykamp, H. (comp.). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Mar 1990. 121p. (In German). Order Number DE91706099. Source: NTIS (US Sales Only), PC A06/MF A01.

This report gives a survey of the research work done at the Institute for Material and Solids Research at Karlsruhe. The following subjects are dealt with: Instrumental analysis; producing thin films; corrosion; failure mechanism and damage analysis; fuel elements, ceramic nuclear fuels and can and structure materials for fast breeder reactors; material problems and ceramic breeding materials for nuclear fusion plants; glass materials for the treatment of radioactive waste; super-conducting materials; amorphous metals, new high alloyed steels; ceramic high performance materials; hard materials; compound materials and polymers. (MM).

3601 Metals and Alloys

Refer also to citation(s) 50359, 50362, 50366, 50453, 50549, 50559, 50613, 50615, 50651, 50652, 50741, 50782, 50785, 50787, 50921, 51033, 51091, 51093, 51272, 51281, 51351, 51389, 51483, 51577, 51604, 51611, 52005, 52274, 52296, 52297, 52306, 52351, 52496, 52515

51117 (AD-A-223273/4/XAB) **High-performance brittle matrices and brittle-matrix composites. Book 1. Final report, 15 March 1986-30 September 1989.** Evans, A.G.; Mehrabian, R. California Univ., Santa Barbara, CA (USA). 31 Dec 1989. 182p. Contract N00014-86-K-0178. Source: NTIS, PC A09/MF A01.

See also Book 2, AD-A223 274.

The primary intent of this research was the development of composites having an acceptable combination of toughness and oxidation resistance. The research was closely coordinated with the DARPA/ONR URI program at UCSB concerned with high temperature, high performance composites. The study comprised three tasks. The first task was to study phase equilibria, solidification pathways and toughness properties of intermetallics, such as oxidation resistant Ti-Al-Ta and Nb-Al-Si alloys, and ceramics. These studies were then combined with interface interaction studies between the matrix microstructure and ductilizing/toughening particulates an fibers. The second task was a basic study of interface structure and chemistry as it relates to the mechanical properties of the interface. The third task involved studies on aluminum and copper matrix composites. These studies were concerned with developing an understanding of creep resistance.

51118 (AD-A–223274/2/XAB) **High-performance brittle matrices and brittle-matrix composites. Book 2. Final report, 15 March 1986-30 September 1989.** Evans, A.G.; Mehrabian, R. California Univ., Santa Barbara, CA (USA). 31 Dec 1989. 285p. Contract N00014-86-K-0178. Source: NTIS, PC A13/MF A02.

See also Book 1, AD-A223 273.

The primary intent of this research was the development of composites having an acceptable combination of toughness and oxidation resistance. The research was closely coordinated with the DARPA/ONR URI program as UCSB concerned with high temperature, high performance composites. The study comprised three tasks. The first task was to study phase equilibria, solidification pathways and toughness properties of intermetallics, such as oxidation resistance Ti-Al-Ta and Nb-Al-Si alloys, and ceramics. These studies were then combined with interface interaction studies between the matrix microstructure and ductilizing/toughening particulates and fibers. The second task was a basic study of interface structure and chemistry as it relates to the mechanical properties of the interface. The third task involved studies on aluminum and copper matrix composites. These studies were concerned with developing an understanding of creep resistance.

51119 (AD-A–223468/0/XAB) **Beryllium-metal supply options.** National Academy of Sciences - National Research Council, Washington, DC (USA). National Materials Advisory Board. 1989. 121p. (NMAB–452). Source: NTIS, PC A06/MF A01.

The importance of an uninterrupted supply of beryllium metal for the U.S. military and aerospace effort is described and the means by which the single supplier in the western world could meet present and future environmental requirements is examined. Cooperation between government and related activities is suggested. Major recommendations are directed toward upgrading existing facilities and processes for extracting beryllium; use of the gas atomization process in lieu of the current beryllium powder-production method; utilization of near-set-shape technology in making beryllium hardware; establishment of a separate facility for electrorefining, scrap recycling, gas atomization and near-net-shape consolidation; Control of DOD scrap; Improving the beryllium monitoring system; and the continuation of efforts to reduce worker exposure to beryllium particulates.

51120 (AD-A–223576/0/XAB) **Thin films, composites, and superconducting junctions. Interim report, 1 October 1984-31 March 1985.** Gaballe, T.H. Stanford Univ., CA (USA). Dept. of Applied Physics. Aug 1985. 16p. Contract F49620-83-C-0014. Source: NTIS, PC A03/MF A01.

The important issue of how the superconducting transition temperature Tc in disordered system changes near the M-I transition where strong localization (k_F 1 about 1) is expected has been studied in the Mo-Ge system. In the high Mo concentration, which is in the weakly localized regime, Tc decreases linearly with decreasing Mo concentration. In this region the ratio of electron-phonon coupling constant lambda to the bare density of states $N_b(O)$ is constant, which is consistent with the Varma-Dynes tight-binding model. An extrapolation of the linear behavior of Tc in this regime yields the disappearance of Tc near 35 at. % Mo. Superconductivity in very thin films of niobium has been investigated. By use of the ion gun which has been installed in the evaporator it has been possible to identify 3 separate mechanisms which contribute to the reduction in Tc as the film thickness is decreased, namely lifetime broadening, proximity effect and localization. A small single grid ion source has been constructed in order to promote the growth of metastable films at low temperatures. Process has been made on a new ultra high vacuum M.B.E. evaporator.

51121 (BISI–26978) **Highly corrosion-resistant Type 304ULC stainless steel for nuclear fuel reprocessing plants.** Inazumi, T. (Nippon Kokan K.K. (Japan). Iron and Steel Research Labs.); Nakagawa, H.; Yoshitake, A.; Tamura, M.; Nagamine, T. Institute of Metals, London (UK). [1990]. 8p. Translated from Bull. Jpn. Inst. Met. (1988) v. 27(5) p. 382-384. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Bull. Jpn. Inst. Met. (1988) v. 27(5) p. 382-384.

In view of the widespread application of 304 stainless steel for most facilities and pipework in nuclear fuel reprocessing plants, research into improving its corrosion resistance has been undertaken. The current objective has been to optimize the chemical composition of the steel within the frame of the JIS standard specifications using a system of components involving an increase in the Cr and Ni contents as far as the SUS304L specification at an ultralow C content. The corrosion resistance has also been investigated through variation in the contents of Si, N, P, etc. within the component specification. The resulting optimized steel offers a corrosion resistance 20-30% better than conventional steels. Investigations of the effects of heat treatments show, however, that when the P and C contents are limited to a suitable range and the steel is suitably aged, it has a corrosion resistance equivalent to that of 310 stainless steel. (author).

51122 (CONF-900936–10) **Application of ion implantation to electrochemical studies.** Vallet, C.E.; White, C.W. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 7. international conference on ion beam modification of materials; Knoxville, TN (USA); 9-14 Sep 1990. Order Number DE91000708. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The application of ion implantation to electrochemical studies is illustrated with a study of electrocatalysis of the chlorine evolution reaction at RuO_2, IrO_2, TiO_2 mixed oxide anodes in chloride solutions. Electrode/solution interfaces of well defined catalyst composition are generated in a reproducible manner by implantation of Ru (or Ir) into Ti followed by in situ oxidation of the near surface titanium alloys. Ion implantation enables the tailoring on an atomic scale of an electrochemical interface. Analysis by Rutherford backscattering adds the ability of quantitative mechanistic study in terms of actual ion concentration at the interface. In addition, ion implantation, as a processing technique, creates new materials with improved properties which may have future practical use in catalytic materials.

51123 (CONF-9005183–, pp. 51-67) **Process controllability in gas metal arc-welding: Micro and macroscopic problems.** Eagar, T.W. (Massachusetts Institute of Technology, Cambridge (USA)); Hardt, D.E.; Smartt, H.B.; Johnson, J.A. Argonne National Lab., IL (USA). [1990]. DOE Contract AC07-76ID01570 ;FG02-85ER13331. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The process of Gas Metal Arc Welding involves a complex transformation of the weld and base metals, originating with the development of droplets at the consumable electrode, and ending in the weld bead as a re-solidified mass of specific metallurgy and geometry. In this paper, work performed jointly by MIT and INEL on the latter topic is described, with an emphasis here on improving process controllability. By examining a true multivariable control problem for geometry, the basic process causality and range of control are identified. The latter is found to be quite limited for the outputs of weld width, depth and height. The need for process modification to overcome this is evident, and such modification begins with a better understanding of droplet formation mechanisms, transfer dynamics and transfer mode detection. Experiments examining droplet velocities are described, and a stored energy theory is developed to account for unexpectedly high initial droplet velocities. Droplet size and frequency relationships are then shown to be determined by a simple static force balance. However, unless the existence of a significant taper at the end of the electrode is included in this calculation, considerable errors result. With such tapers included, the transition to smaller, more frequent droplets is closely modeled. It is also shown that current pulsing in this taper region can lead to maximal transfer rates, and potentially to a broader process operating range. Finally, a measurement method for transfer mode detection is presented that provides a basis for in-process control, thereby potentially permitting the extension of the now limited control range envelope. 13 refs., 16 figs.

51124 (CONF-9005183–, pp. 111-118) **Viscoplasticity theory based on overstress: The modeling of cyclic hardening of AISI Type 304 stainless steel.** Krempl, E. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Choi, S.H. Argonne National Lab., IL

(USA). [1990]. DOE Contract FG02-86ER13566. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

At room temperature, annealed AISI Type 304 Stainless Steel exhibits rate dependence which manifests itself in rate sensitivity, creep and relaxation. For cyclic loading significant hardening is observed. It is well known that this hardening depends on the path and seems to be most pronounced under 90° out-of-phase cycling. Other paths show various degrees of cyclic hardening. At the same effective strain range, the hardening under nonproportional loading is much more pronounced than under proportional loading. Experiments show that the rate sensitivity is, as a first approximation, unchanged by the significant hardening which is therefore rate independent. The small strain, isotropic viscoplasticity theory based on overstress (VBO) is used to model these phenomena. The theory is of the unified type and does not employ yield or loading/unloading criteria. The inelastic strain rate is a function of the overstress, the difference between the stress and the equilibrium stress, which is a state variable of the theory. Its growth law is the repository for modeling nearly elastic regions and hysteresis. Under constant strain rate loading, the theory admits asymptotic solutions which show that the stress is composed of a viscous, a rate-independent (plastic) and a kinematic contribution. For the modeling of cyclic hardening, a growth law for the rate independent contribution of the stress is formulated. It models a different growth for proportional and nonproportional as well as cyclic and monotonic loading. Numerical experiments for homogeneous states of stress are performed by integrating the stiff, nonlinear ordinary differential equations using the IMSL routine DGEAR. 20 refs., 7 figs.

51125 (CONF-9005183–, pp. 119-128) **A micromechanical viscoplastic stress-strain model.** Jordan, E.H. (Univ. of Connecticut, Storrs (USA)); Shixiang Shi; Walker, K.P. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

A constitutive model for Hastelloy-X polycrystalline metals is derived from the known deformation behavior of single crystals of the same metal using a self-consistent formulation which averaged the response of many randomly oriented single crystals while including the interaction of effects of the differently oriented crystals on each other. The single crystal behavior which has been used was developed by summing postulated slip behavior on crystallographic slip systems. The predictive capabilities of the single crystal model for Hastelloy-X will be presented along with some observed anomalous behavior of the single crystal at 1600°F which was observed in the experiments, but is not yet modeled well. Single crystal properties used for input to the model are currently being determined experimentally for Hastelloy-X. Using these properties the behavior of polycrystal Hastelloy-X has been predicted and then compared with polycrystalline experiments. In addition, methods other than the self-consistent method are being developed including an anisotropic self consistent model. A model based on periodicity and two models addressing grain boundary sliding. 10 refs., 3 figs.

51126 (CONF-9005183–, pp. 213-220) **Brittle deformation of solids: Micro-to-macro transition.** Krajcinovic, D. (Arizona State Univ., Tempe (USA)); Basista, M.; Sumarac, D. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The paper suggests a phenomenological damage theory for perfectly brittle response of solids. The theory is based on the micromechanics of the brittle deformation processes. The compliance is identified as the flux and a properly averaged energy release rate as the affinity. The paper identifies conditions under which the damage potential exists. 16 refs.

51127 (DOE/ER/45281–5) **Magnetic multilayer interface anisotropy: Technical progress report, August 1, 1990–December 31, 1990.** Pechan, M.J. Miami Univ., FL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER45281. Order Number DE91000702. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Ni/Mo and Ni/V multilayer magnetic anisotropy has been investigated as a function of Ni layer thickness, frequency and temperature. Variable frequency ferromagnetic resonance (FMR) measurements show, for the first time, significant frequency dependence associated with the multilayer magnetic anisotropy. The thickness dependence allows one to extract the interface contribution from the total anisotropy. Temperature dependent FMR (9 GHz) and room temperature magnetization indicate that strain between Ni and the non-magnetic layers is contributing significantly to the source of the interface anisotropy and the state of the interfacial magnetization. In order to examine the interface properties of other transition metal multilayer systems, investigations on Fe/Cu are underway and CoCr/Ag is being proposed. ESR measurements have been reported on Gd substituted YBaCuO superconductors and a novel quasi-equilibrium method has been developed to determine quickly and precisely the transition temperature. During the next project period the P.I. proposes to (1) extend the variable frequency FMR measurements to low temperature, where extremely large interface anisotropies are known to obtain in Ni/Mo and Ni/V and are proposed to exist in Ni/W; (2) obtain accurate dc anisotropies via a novel, variable temperature torque magnetometer currently under construction; (3) expand upon his initial findings in Fe/Cu multilayer investigations; (4) begin anisotropy investigations on Co/Ag and CoCr/Ag multilayers where the easy magnetization direction depends upon the Cr concentration; (4) make and characterize Bi based superconductors according to resistivity, thermal conductivity and thermoelectric power and construct YBaCuO based superconducting "loop-gap" resonators for use in his magnetic resonance work.

51128 (IS-T–1416) **The interactions of water and perfluorodiethyl ether on Ru(100).** Leavitt, P. Ames Lab., IA (USA). 21 Sep 1990. 169p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000199. Source: NTIS, PC A09/MF A01 - OSTI; GPO Dep.

We have studied the interactions of water and perfluorodiethyl ether on Ru(100) in order to model the effects of surface structure and humidity on the bonding and decomposition of perfluoroalkyl ether lubricants with metal surfaces. In order to understand the interactions on Ru(100), we have first investigated the interactions of each of these adsorbates alone on the clean surface. The interactions of water with Ru(100) have been studied using both thermal desorption spectroscopy (TDS) and electron energy loss spectroscopy (EELS). From these studies we conclude that a small amount of water dissociates on this surface (5–10% of a monolayer), but water is adsorbed in a predominantly molecular form on this surface with an increasing degree of hydrogen-bonding with increasing coverage. The effects of hydrogen and oxygen coadsorption on the interactions of water with this surface have also been studied using TDS. Finally, the interactions of coadsorbed water and perfluorodiethyl ether on Ru(100) have been investigated using TDS.

51129 (LA-UR–90-3048) **The reaction of vapor-deposited Al with Cu oxides.** Taylor, T.N.; Martin, J.A. Los Alamos National Lab., NM (USA). [1990]. 21p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-901035–1: 37. national American Vacuum Society symposium, Toronto (Canada), 8-12 Oct 1990). Order Number DE91000367. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Interfaces formed by controlled deposition of Al on Cu oxides at 300K have been characterized using Auger electron spectroscopy (AES) and x-ray photoelectron spectroscopy (XPS). When Al is deposited onto a thin oxide grown on Cu(110) by atmospheric exposure, it completely scavenges the oxygen from the substrate material, increasing the O(1s) binding energy by 2.0 eV to give the

value found for atmospheric oxidation of a thin Al film. Similar oxygen behavior is seen for Al deposition on sputter-deposited CuO with an enriched oxygen surface region, where multilayers of Al erase the shakeup satellites in the Cu(2p) region of the XPS spectrum to give features like those exhibited by Cu_2O or metallic Cu. Having calibrated the fluence of the Al source with Rutherford backscattering spectrometry, the attenuation of the Cu $2p_{1/2}$ satellite after approximately one monolayer of Al deposition is associated with the removal of oxygen from the top 20 Å of the CuO. Approximately 7–8 equivalent monolayers of Al are converted to an oxide in the initial rapid reaction process. Further deposition leads to progressive development of the metallic Al signature in both the XPS and AES spectra. These measurements clearly demonstrate the dominant role played by Al, a strong oxide former, when it is placed in intimate contact with the distinctively weaker Cu oxide. 9 refs., 5 figs.

51130 (LA-UR–90-3166) **Magnetic structures of actinide materials by pulsed neutron diffraction.** Lawson, A.C.; Goldstone, J.A.; Huber, J.G.; Giorgi, A.L.; Conant, J.W.; Severing, A.; Cort, B.; Robinson, R.A. Los Alamos National Lab., NM (USA). [1990]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-901004–5: Conference on magnetism and magnetic materials, San Diego, CA (USA), 30 Oct - 2 nov 1990). Order Number DE91000373. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We describe some attempts to observe magnetic structure in various actinide (5f-electron) materials. Our experimental technique is neutron powder diffraction as practiced at a spallation (pulsed) neutron source. We will discuss our investigations of α-Pu, δ-Pu, α-UD_3 and β-UD_3. β-UD_3 is a simple ferromagnet: surprisingly, the moments on the two non-equivalent uranium atoms are the same within experimental error. α-UD_3, α-Pu and δ-Pu are nonmagnetic, within the limits of our observations. Our work with pulsed neutron diffraction shows that it is a useful technique for research on magnetic materials.

51131 (LA-UR–90-3347) **Influence of strain rate on the structure/property of Ti-48Al-1V.** Gray, G.T. III. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-901008–4: Fall meeting of the Minerals, Metals and Materials Society on physical metallurgy and materials in conjunction with materials week and the material applications and services exposition, Detroit, MI (USA), 7-11 Oct 1990). Order Number DE91000172. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

While the influence of strain rate on the structure/property response of pure titanium and a variety of titanium alloys has been extensively studied, the effect of strain rate on the stress-strain and deformation response of titanium aluminides remains largely unknown. In this paper, a preliminary study of the effect of strain rate and temperature on the substructure evolution and mechanical response of a (48Al-1V)TiAl alloy is presented. The compressive true stress-true strain response of Ti-48Al-1V was found to depend on both the applied strain rate, varied between 0.001 and 7500 s^{-1}, and the test temperature, varied between 25 and 700°C. The rate of strain hardening in Ti-48Al-1V is seen to increase with increasing strain rate. The substructure evolution of Ti-48Al-1V was observed to depend on the applied strain rate and temperature of deformation. The substructure of Ti-48Al-1V deformed to $\varepsilon = 0.20$ at 0.001 s^{-1} at 25°C was seen to consist of predominately random dislocation debris and isolated grains containing a high density of stacking faults. The majority of the dislocations appear to be [111] 1/2⟨110⟩ unit type ordinary dislocations which is consistent with previous observations on Ti-48Al. Increasing the rate of deformation at room temperature to 75000 s^{-1} is seen to increase the density of deformation twins and the overall random dislocation debris density. The substructure of Ti-48Al-1V deformed a at high-strain-rate at elevated temperatures was seen to be quite similar to that observed following high-rate deformation at room temperature except for an even higher incidence of twinning. The defect generation and the rate sensitivity of TiAl are discussed as a function of strain rate and contrasted to that observed in conventional titanium alloys. 34 refs., 8 figs.

51132 (LBL–26455, pp. 56) **Surface vibrational spectroscopy of molecular adsorbates on metals and semiconductors by infrared-visible SFG.** Superfine, R.; Guyot-Sionnest, P.; Hunt, J.H.; Kao, C.T.; Shen, Y.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Surface vibrational spectroscopy is of central importance for surface studies. Most of the existing spectroscopic techniques, unfortunately, have serious limitations. The authors recently developed infrared-visible SFG technique has a number of clear advantages over existing techniques. Like optical SHG, SFG is highly surface-specific and is applicable to all interfaces accessible by light. With the help of ultrashort pump pulses, it has the potential of monitoring in situ surface dynamics, surface reactions, and intermediate transient species with picosecond time resolution. In several recent publications, they have successfully demonstrated the possibility of using SFG to obtain vibrational spectra of monolayers of molecules adsorbed at air/liquid, air/glass, and liquid/glass interfaces. However, to many researchers, studies of molecules adsorbed on metals and semiconductors are far more interesting because of their relevance to surface catalysis and surface preparation of electronic devices. They have tried the SF surface spectroscopic technique on metals and semiconductors. They use the molecular adsorbate octadecyltrichlorosilane (OTS) as an example. The spectra of CH stretches of OTS on Si and Al and ethylidyne on Rh(111) are presented as examples. The signal-to-noise ratio in the present experiment was not optimized. By choosing a proper beam geometry, the authors can anticipate an improvement of one order of magnitude in their SF signal. This should make the technique extremely attractive for future dynamic studies of selective molecules adsorbed on metals and semiconductors.

51133 (LBL–26455, pp. 61) **Spin-wave dynamics in a ferrimagnetic sphere.** Bryant, P.H.; Jeffries, C.D.; Nakamura, K. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

An experimental study has been made of the interaction between spin-wave modes excited in a sphere of yttrium iron garnet by pumping the Suhl subsidiary absorption at 9.2 GHz with the dc field parallel to [111]. The dynamical behavior of the magnetization is observed under high resolution by varying two control parameters, dc field and microwave pump power. Within this parameter space, quite varied behavior is found: (i) onset of the Suhl instability occurs by excitation of a single spin-wave mode with very narrow linewidth (< 0.5 G); (ii) when two or more modes are excited, interactions lead to auto-oscillations with a systematic dependence of frequency on pump power, these oscillations displaying period doubling to chaos; (iii) quasiperiodicity, locking, and chaos occur when three or more modes are excited; (iv) abrupt transition to wide-band power spectra (i.e., turbulence) occurs with hysteresis; and (v) irregular relaxation oscillations and aperiodic spiking behavior occur. A theoretical model has been developed from first principles, using the plane-wave approximation and including anisotropy effects, obtaining the lowest-order nonlinear interaction terms between the excited modes. Bifurcation behavior has been examined, and dynamical behavior has been numerically computed and compared to the experimental data, explaining a number of features. A theory has been developed regarding the nature of the experimentally observed relaxation oscillations and spiking behavior based on the interaction of weak and strong modes, and this theory has been demonstrated in the numerical simulations.

51134 (LBL–26455, pp. 74-75) **An in situ grazing-incidence x-ray diffraction study of the initial stages of electrochemical growth of lead on silver(111).** Kortright, J.; Ross, P. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The first layer of lead atoms on Ag(111) electro-deposited from acetate or perchlorate solution forms a hexagonal close-packed 2D lattice that is incommensurate with the silver lattice due to the large atomic mismatch (~ 18%). The monolayer is stable over an

~ 180 mV region of electrochemical potential. Within this potential region, the 2D lattice constant is a function of potential, with Pb-Pb distance decreasing with increasing cathodic potential to a maximum compression of 2.8% (versus bulk Pb) at the onset of multilayer growth. The twist angle between the Pb and Ag(111) lattice vectors was 4.4° and was independent of potential. The Novaco-McTague theory of rotational epitaxy predicts a 6.5° angle for an atomic-size mismatch of 18%, and a change of 0.5° in twist angle even for a change in 2D lattice constant of only 1.5%. These deviations from theory are not understood but may come from buckling of the Pb layer along with compression. Because of the compressive strain, lead was not deposited epitaxially on this first layer but instead grew in multilevel islands oriented in the direction normal to the substrate but randomly misoriented in the plane of the substrate. The initial underpotentially deposited monolayer (i.e., the strained epilayer) reconstructs after the deposition of approximately five equivalent monolayers of bulk lead.

51135 (LBL–29184) **Research on the metallurgical determinants of formability in electrogalvanized sheet.** Shaffer, S.J.; Nojima, W.E.; Skarpelos, P.N.; Morris, J.W. Jr. Lawrence Berkeley Lab., CA (USA). May 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-901008–2: Fall meeting of the Minerals, Metals and Materials Society on physical metallurgy and materials in conjunction with materials week and the material applications and services exposition, Detroit, MI (USA), 7-11 Oct 1990). Order Number DE91000189. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effective coefficient of friction in draw-bead simulation tests of two-sided electrogalvanized steels (DBS-μ) varies significantly. Analysis of commercial samples suggests that the surface roughness and crystallographic texture of the coating are important variables. To isolate the effect of texture one-side galvanized samples of various textures were made in a laboratory simulator and tested in draw-bead simulation and strip-draw. The data show a consistent variation of DBS-μ with texture. Differences between the DBS and strip-draw tests apparently reflect differences in the degree of deformation on initial contact with the bead. The DBS-μ also increases when the surface is smooth on the microscale, probably because of interaction with the lubricant. However, the results do not seem to explain the quantitative differences between commercial specimens, which suggests that other metallurgical factors, such as surface roughness and the properties of the underlying steel, and often dominate.

51136 (LBL–29185) **Textural characterization and its applications on zinc electrogalvanized steels.** Shaffer, S.J. (Lawrence Berkeley Lab., CA (USA)); Morris, J.W. Jr.; Wenk, H.R. Lawrence Berkeley Lab., CA (USA). May 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-901008–3: Fall meeting of the Minerals, Metals and Materials Society on physical metallurgy and materials in conjunction with materials week and the material applications and services exposition, Detroit, MI (USA), 7-11 Oct 1990). Order Number DE91000354. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Methods of characterization and description of crystallographic texture in both laboratory prepared and commercial zinc electrogalvanized steel sheets are presented. Specific examples of simple in-plane normalization techniques, and pole figures obtained from deformation and friction studies are presented. Strong evolutions of texture are observed in friction testing. Coatings containing orientations which are unfavorable for slip show evidence of twinning and possibly recrystallization. The use of the complete orientation distribution function (ODF) is discussed with reference to deformation modelling studies and quantitative analysis of textural changes with depth. Other ODF applications include extraction of textural changes solely of the deformed surface layer resulting from friction testing as well as texture changes with coating thickness in as deposited coatings. 27 refs., 10 figs., 1 tab.

51137 (LBL–29311) **A study of chromium carbide precipitation at interphase boundaries in stainless steel welds.** Willis, C.F. Lawrence Berkeley Lab., CA (USA). Apr 1990. 59p. Sponsored by U.S. DOE Defense Programs; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE91000360. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Sensitization is a deleterious process which can occur in stainless steels. It is caused by grain boundary or phase boundary precipitation of chromium carbides and the resulting formation of a chromium depleted zone adjacent to these boundaries. The carbides in question actually have the composition $(Cr,Fe)_{23}C_6$ (usually written $M_{23}C_6$), and precipitate in the temperature range 450–900°C. Since a minimum chromium content is required to maintain the passive film necessary for resistance to electrochemical attack, the result of chromium depletion is that the steel becomes "sensitized" to possible intergranular corrosion. Sensitization often occurs as a result of welding operations. The material close to the fusion line reaches temperatures within the sensitization range. This region is called the heat affected zone (HAZ). Since many welds are multi-pass welds, the actual weld bead of one pass may lie in the heat affected zone of the next pass. The weld bead of the first pass might therefore be sensitized. Furthermore there are applications where welds will be exposed to sensitizing temperatures for very long periods of time, such as welded labels on retrievable nuclear waste containers. For these reasons the sensitization behavior of the actual weld-bead microstructures must be understood. It has been known for many years that duplex stainless steels (steels with both ferrite and austenite phases present at room temperature) have superior resistance to intergranular corrosion. A model has been proposed to explain the sensitization behavior of these alloys. This work will be concerned with testing the validity of aspects of this model using transmission electron microscopy and further understanding of the sensitization process in duplex stainless steel welds. 52 refs., 23 figs.

51138 (PB–90-255506/XAB) **New Materials Society: Challenges and Opportunities. Volume 2. New materials science and technology.** Bureau of Mines, Washington, DC (USA). 1990. 294p. Source: NTIS, PC A13/MF A02.

Also available from Supt. of Docs. See also Volume 1, PB–90-255498.

The New Materials Society: Challenges and Opportunities is the Bureau of Mines' most comprehensive report on the subject of advanced materials. The report discusses the current state of affairs in the U.S. materials industry with particular emphasis on recent technology advances in materials. The information in the report reflects the state of the industry in 1988 and contains the best information available during that time. The analysis was based upon discussions with many public and private sector experts in materials science, engineering, and product application and upon extensive literature surveys. The following are topics by Chapter: Chapter 4-New materials technology overview; Chapter 5-Advanced metals; Chapter 6-Metal matrix composites; Chapter 7-Advanced ceramic materials; and Chapter 8-Advanced polymer materials.

51139 (SAND–90-0449C) **Experimental verification of physical model of pulsed laser welding.** Jellison, J.L.; Keicher, D.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9009258–1: Modeling of casting, welding and advanced solidification processes engineering foundation conference, Davos (Switzerland), 16-21 Sep 1990). Order Number DE91000025. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Whereas most experimental and theoretical studies of the role of convection in fusion welding have been concerned with continuous heat sources, a pulsed heat source is the focus of this study. This is primarily an experimental study of the pulsed Nd:YAG laser welding of austenitic stainless steels. 12 refs., 9 figs.

51140 (SAND–90-0993C) **Microstructures of cubic Al_2O_3 precipitates in oxygen-implanted aluminum.** Follstaedt, D.M.; Myers, S.M.; Bourcier, R.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900936–7: 7. international conference on ion beam modification of materials, Knoxville, TN (USA), 9-14 Sep 1990). Order Number DE91000038. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The microstructure of Al ion-implanted at room temperature with 17 at. % O has been characterized with TEM. The alloy has extremely small (1.5–3.5 nm) oxide precipitates whose crystal structure is interpreted to be a disordered version of γ-Al_2O_3 having a fcc lattice of O^{2-} ions with Al^{3+} ions in random interstitial sites.

The small sizes can account for the exceptionally high strength of as-implanted alloys: 2500–3300 MPa. Larger precipitates are found when the alloy is annealed 1/2 hour at 550°C, which is consistent with its somewhat lower strength: 800–1600 MPa. 4 figs.

51141 (SAND–90-1470C) **Conical surface textures formed by ion bombarding 2% Be Cu alloy.** Panitz, J.K.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-901035–2: 37. national American Vacuum Society symposium, Toronto (Canada), 8-12 Oct 1990). Order Number DE91000772. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A homogeneous, micrometer-sized conical surface texture forms on 2% Be-Cu alloy which is bombarded with an argon beam produced by a Kaufman ion source. The dimensions of the features that form strongly depend on: (1) argon energy (from 250 to 1500 eV), (2) fluence (10^{19} to 10^{20} ions/cm^2), and (3) flux (0.1 to 1 mA/cm^2). The texture morphology depends less strongly on the background ambient (Mo vs graphite), earlier alloy heat treatments and the temperature during bombardment (100°C and 450°C). As the texture matures with increasing fluence, the number of large features increases at the expense of the number of small features. The observed relationship between texture formation and ion flux suggests that the evolution of these features is not adequately described by theories predicting that the mature conical sidewall angle is related to the angle of the maximum sputtering yield. These textured surfaces can be coated with other metals for a variety of possible applications including: (1) pulsed power Li+ beam anodes, (2) cold cathode field emission devices, (3) optical absorbers and (4) catalysis supports. 18 refs., 5 figs.

51142 (UCRL–102340) **Order-disorder phenomena in complex alloys: The case of A15-based substitutional alloys.** Turchi, P.E.A. (Lawrence Livermore National Lab., CA (USA)); Finel, A. Lawrence Livermore National Lab., CA (USA). 15 Aug 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–90: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE91000815. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We first discuss the applicability of the Generalized Perturbation Method to the study of ordering phenomena in complex alloys for which stability properties are electronically driven. In particular, according to previous work, it is recalled that a 3D-generalized Ising model is appropriate to address the problem of configurational order in A15-based substitutional alloys. A ground state analysis of this model, including 1st, 2nd, and weak 3rd and 7th pair interactions, generates two new ordered states at the composition A_5B_3 and A_7B, apart from the well known A_3B configuration. The stability of these predicted configurations is examined as a function of temperature and concentration by means of standard statistical techniques. The results are discussed in relation with the experimental situation. 11 refs., 4 figs.

51143 (UCRL–102697) **A molecular dynamics model of the orthogonal cutting process.** Belak, J.F.; Stowers, I.F. Lawrence Livermore National Lab., CA (USA). 16 Jul 1990. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009241–1: 1990 ASPE (American society of photoptical engineers) annual conference, Rochester, NY (USA), 23-28 Sep 1990). Order Number DE90015911. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Material removal, as found in the cutting and grinding processes, is important in many areas of fabrication technology. Examples include high-speed machining by single point turning, surface milling and drilling. An idealized model that contains the essential physics of these processes is the two-dimensional orthogonal cutting geometry. Following the work of Shaw, an attempt is made to obtain a fundamental understanding of the commonly observed phenomena in the chip forming process: the atomistic mechanisms of plastic deformation within the primary shear zone and the observed shear angle (ϕ); the resultant energy flow from the tool doing work; the stress, strain and material flow fields; the morphology of the chip (smooth, segmented, crystalline or amorphous); the role of different depths of cut (t), rake angles (α), and clearance angles (θ); and the role of the tool tip radius, roughness (friction), and wear. The molecular dynamics computer simulation method is an ideal tool for the study of the atomistic mechanisms of these deformation processes. Simulations are performed for a model of copper at room temperature using 10^3–10^6 atoms, depths of cut in the range 1–50nm. and cutting speeds of 1–2500 meters per second (m/s). These simulations are strictly two dimensional (plane strain). Here, focus is on the chip forming process, the atomistic mechanisms of plastic deformation, the flow of energy into the chip and workpiece, and the material flow and stress fields for the orthogonal geometry ($\alpha = 0$), sharp tools, and shallow depths of cut ($t \approx 5$ nm). 5 refs., 3 figs.

51144 (Y–2414-6) **Y-12 Development Division technical progress report, period ending October 1, 1989: Part 6, Environmental technology.** Kosinski, F.E. (comp.). Oak Ridge Y-12 Plant, TN (USA). 30 Aug 1990. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. Order Number DE91000077. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Shallow land burial in Bear Creek Burial Ground (BCBG) of depleted uranium and uranium alloy chips was discontinued. These materials are now being processed at the Uranium Chip Oxidation Facility (UCOF). Some of the depleted uranium chips, formerly taken to BCBG, were oxidized in 5-, 10-, 15-, and 20-lb batches to determine the optimal processing weight that would reduce the overall flameout frequency to one that complies with UCOF safety documentation. The goal of the Y-12 Plant Development Division was to reduce the flameout frequency to 1%. Batches of uranium-titanium alloy mill, mixed, and suspect chips were also processed at UCOF using modified operating procedures. Most of the depleted uranium and uranium alloy chips, except for the sawfines, were safely oxidized at UCOF with a minimum number of flameouts. 1 fig., 14 tabs.

51145 Nanolayer reactions in aluminum-metal interfaces. Barrera, E.V. (Division of Materials Science, Dept. of Applied Science, Brookhaven National Lab., Upton, NY (US)); Ruckman, M.W.; Heald, S.M. pp. 69-76 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

Surface extended x-ray absorption fine structure (SEXAFS) measurements on the nanometer level were made for Al/M interfaces where M was Cu or Ni. This paper reports on the samples studied immediately after deposition and after heat treatments. Significant differences in interface reactions were observed depending on deposition direction (Cu on Al or Al on Cu) and the amount of mixing was also related to whether M was Cu or Ni. The SEXAFS measurements revealed that there were no detectable amounts of C or O present. One percent Zn was observed to be in the Al layers. The results obtained from the as-deposited interfaces correlate well with data obtained from buried interfaces of like element combinations.

51146 A comparison of electrocatalytic and microstructural properties in platinum and platinum-chromium dispersed catalysts. Kroen, C.F. (Virginia Univ., Charlottesville, VA (USA). Dept. of Materials Science); Soner, G.E.; Taylor, S.R.; Cahen, G.L. Jr. pp. 171-172 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Alloying platinum dispersed catalysts with base metals has been shown to improve the activity for the oxygen reduction reaction in hot, concentrated (200°C, 100 wt.%) phosphoric acid. Specifically, this has also been demonstrated for platinum-chromium alloys. The mechanism for this increased activity has not been fully determined. Among other factors, changes in surface structure, surface free energy, oxidation potential and catalyst-support interaction as a result of alloying platinum with base metals may be responsible for altering the activity. The role of the conductive catalyst support, catalyst distribution, and the effective catalyst composition and structure are being investigated in order to more fully evaluate the mechanism responsible for this observed increase in activity. This investigation focuses primarily on relating the electrochemical and

microstructural characteristics of dispersed platinum and platinum-chromium alloy catalyst electrode operated in hot, concentrated phosphoric acid.

51147 Localized corrosion and its inhibition by CO_2 of aluminium and Al-0.5%Cu in dilute HF solutions. Scully, J.R. (Sandia National Labs., Albuquerque, NM (USA)); Frankenthal, R.P.; Hanson, K.J.; Siconolfi, D.J.; Sinclair, J.D. pp. 201 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Aluminum, the most commonly used metallization on silicon integrated circuits is often alloyed with silicon and/or copper to meet process and reliability requirements. However, copper, due to its low solubility in aluminum, may form susceptibility to corrosion during both wet chemical etching and dry reactive ion etching with plasmas containing chlorine or fluorine. On the other hand, CO_2 has been reported to inhibit the corrosion of aluminum. Since the dimensions of metallizations are of the order of micrometers, even the smallest pits can seriously affect device performance. Therefore, an understanding of corrosion mechanisms of aluminum metallizations by regrets used during processing and of methods for inhibiting such corrosion are required. The authors discuss their study of the localized corrosion of sputter-deposited aluminum (99.999%) and aluminum-0.5%(wt.) copper alloy in thin films (1-2μ thick) in dilute ($\leq 10^{-3}$M) aqueous hydrofluoric acid solution and the inhibition of this localized corrosion by CO_2 that is bubbled through the solution.

51148 Current distribution during electroplating of circuit board through-holes. Hazlebeck, D.A. (Dept. of AMES/Chemical Engineering, Univ. of California, San Diego, La Jolla, CA (US)); Talbot, J.B. pp. 217-218 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

In this paper, a model is developed for the current distribution during electroplating of a through-hole with copper which includes the effects of convection, diffusion and ohmic transport, and also considers the effects of additives on the plating kinetics. The major assumptions of the model are that the bulk solution is well mixed and the velocity profile within the through-hole is that of fully-developed laminar flow. The solution of the model is used to examine the effects of plating variables on uniformity without additives in the bath and the operating conditions for different regimes of control. The effects of additives to the plating bath on uniformly and the use of various plating process strategies to improve plating uniformity are investigated.

51149 Location of defects on rotating cylinder electrodes. Isaacs, H.S. (Brookhaven National Lab., Upton, NY (USA). Applied Science Dept.); Davenport, A.J. pp. 216 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC02-76CH00016. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Rotating electrodes have been studied to determine the distribution of currents across their surfaces. On a heterogeneous electrode, rotation gives rise to an ac current which can be used in conjunction with a lock-in amplifier to analyze the current distribution. This study also employs this approach and presents data relating to the measurement of surface defects on rotating cylinders and within recesses. Difficulties are often experienced in depositing coatings or electroplating in recessed areas or groves, leaving the poorly coated or uncoated regions susceptible to corrosion. If a recess is deep then microscopic observation may be difficult with no direct line of sight. In many cases the choice of a specific electrolyte enables higher current densities to flow at the defects without damage to the underlying metal. Detection of the higher current density identifies the presence and location of these sites.

51150 The determination of local impedances of metal surfaces by a scanning microelectrode technique. Lillard, R.S. (Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Materials Science and Engineering); Morran, D.J.; Isaacs, H.S. pp. 214 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC02-76CH00016. Grant N00014-89-J-1180. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

This paper discusses how electrochemical impedance spectroscopy (EIS) has proven to be a useful technique in evaluating many corrosion processes. It has allowed investigators to characterize electrochemical processes at solution electrode interfaces in a non-destructive manner and is capable of extracting information such as the corrosion rates of metals. The state-of-the-art, however, does have pit-falls, the most limiting being surface averaging; that is by the nature of the method of measurements are averaged over the entire surface. In some cases, assuming uniform behavior at the solution electrode interface may present no major problems. In the case of localized corrosion, though, the current distribution will be non-uniform. An example of this is pitting, a pit may exist on an otherwise inactive or passive surface.

51151 The electronic structure of $\Sigma 5$ grain boundaries in Cu. Sowa, E.C., Gonis, A. (Lawrence Livermore National Lab., Livermore, CA (US)); Zhang, X.G. pp. 395-400 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

The authors present first-principles calculations of the densities of states (DOS's) of unrelaxed and relaxed twist and tile grain boundaries (GB's) in Cu. The relaxed configurations were obtained through the use of the embedded atom method (EAM), while the DOS's were calculated using the real-space multiple-scattering theory (RSMST) approach recently introduced in the literature. The DOS's of GB's are compared against those of bulk materials as well as against one another. Although the RSMST calculations are still not self-consistent, these comparisons allow the authors to verify certain expected trends in the DOS's, and to verify the usefulness and reliability of their method.

51152 Structure of a near-coincidence $\Sigma 9$ tilt grain boundary in aluminum. Mills, M.J. (Sandia National Lab., Livermore, CA (US)); Thomas, G.J.; Daw, M.S.; Cosandey, F. pp. 365-370 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

A systematic study of the structure of tilt grain boundaries in aluminum has been initiated. High resolution transmission electron microscopy is being used to examine the interface structure of several bicrystals with ⟨110⟩ tilt axes. In this paper, the authors report the structure determination of a grain boundary close to the $\Sigma 9$ ($2\bar{2}1$) symmetric orientation. The grain boundary plane, which appears wavy at lower magnification, is actually composed of atomically flat microfacets. Two distinct, symmetric structures with ($2\bar{2}1$) boundary planes have been identified within individual microfacets. These observations have been compared with structures calculated using the embedded atom method. The semi- quantitative comparison between the observed and predicted grain boundary structures is accomplished using multislice image simulations based on the calculated structures. The results of these comparisons and the evaluation of the relative energies of the microfacets are discussed.

51153 The application of glancing angle EXAFS to study the structure of platnum-nickel multilayers. Lamble, G.M. (North Carolina State Univ., NC (US)); Heald, S.M.; Clemens, B.M. pp. 389-394 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

Recent reports have correlated the mechanical properties of multilayers with a structural expansion of the constituents. Whether this expansion is an interface of bulk effect remains in dispute. The

authors apply the technique of glancing angle EXAFS to obtain information about the local structure and multilayer composition and use these results to shed light on certain aspects of this controversy. The experiments were performed on platinum-nickel multilayers of varying bilayer thickness. Measurements were made by fluorescence detection of EXAFS beyond both the Pt L_{III} and the Ni K edges. Considerable interlayer mixing is evident, as is the presence of order within the interface. The authors additionally find that the bulk metallic character is retained within the layers.

51154 Electrodeposition of uranium metal by reduction of uranium oxides in molten LiF-KF=NaF-CaF $_2$-UF_4. Pao, D.S. (Argonne National Lab., IL (USA)); Burris, L.; Steunenberg, R.K.; Tomczuk, Z. pp. 357-358 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107--: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Although electrolytic reduction of uranium oxides was shown to be feasible in the early 1960's it is recognized that considerable improvement in the electrolytic reduction technology must be achieved for practical applications. This exploratory work on electrolytic reduction of uranium oxide was undertaken to investigate potential improvements in the technology. The approach taken was to deposit solid uranium metal directly on a solid cathode at temperatures below the melting point of uranium (1132°C). The lower temperature electrolytic reduction process has several advantages over the existing chemical reduction processes. It lessens materials problems and special heating and insulating requirements associated with high-temperature operations. It removes most impurities. It does not produce the large quantities of byproduct oxides wastes typical of chemical reduction processes.

51155 Numerical model of bond strength measurements. Nutt, G.L. (Chemistry and Materials Science Dept., Lawrence Livermore National Lab., Livermore CA (US)). pp. 465-472 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

The authors have reported bond strength measurements of metal/ceramic interfaces using shock waves to separate the bond by spallation. The technique relies on the interpretation of the free surface velocity of the metal film as it is spalled from the substrate. The authors answer several questions relating to the details of the interaction of the shock with the interface. Specifically, they examine the role of sound speeds in the measurements. The authors also calculate the plastic strain in the bond region and verify the theory relating to the jumpoff velocity of the scab to the bond strength.

51156 High-resolution electron microscopy of interfaces in AlN-braze metal alloy systems. Carin, A.H. (Center for Micro-Engineered Ceramics and Department of Chemical and Nuclear Engineering, Univ. of New Mexico, Albuquerque, NM (US)). pp. 425-432 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

The microstructural aspects of active brazing of AlN with a Ag-Cu-Ti alloy have been investigated. A series of reaction product layers are formed. TiN is produced in contact with the polycrystalline, bulk AlN. High-resolution transmission electron microscopy and microdiffraction demonstrate that some of the TiN grains at the interface display specific orientation relationships with respect to the adjoining AlN crystallites. As has sometimes been observed in studies of epitaxy in other systems, these relationships are not necessarily those that provide the minimum geometrical mismatch between one or more sets of lattice planes. Farther from the substrate, an η-type nitride phase with composition $(Ti,Cu,Al)_6N$ occurs as a reaction product. High-resolution images confirm the absence of amorphous or crystalline intervening phases at the TiN-η interface and at η grain boundaries.

51157 A mathematical model for anomalous codeposition of nickel-iron on a rotating disk electrode. Hessami, S. (Lawrence Berkeley Lab., CA (USA). Materials and Chemical Sciences Div.); Tobias, C.W. pp. 452 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC03-76SF00098. (CONF-8910107--: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The importance of hydrolysis in the deposition of single metals has been described. The authors include the effect of metal-hydroxide ions in the mechanism of nickel-iron codeposition. The kinetic parameters of the alloy deposition are assumed to be the same as those of the single metals involving the discharge of both metal and metal-hydroxide ions; however, during codeposition, the metal-hydroxide ions are allowed to discharge only at a fraction of surface sites proportional to their interfacial concentration. The interfacial concentrations of the metal ions, metal-hydroxide ions and hydrogen ion are calculated by solving the convective diffusion equations coupled with the homogeneous dissociation reactions of water and metal-hydroxide ions. The authors show recent experimental results along with simulation results.

51158 Corrosion of C implanted Fe-Cr alloys. Sorensen, N.R. (Sandia National Labs., Albuquerque, NM (USA)); Nelson, G.C.; Picraux, S.T.; Arnold, G.W. pp. 483 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC04-76DP00789. (CONF-8910107--: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The authors are using ion implantation to study the corrosion and passivation behavior of glassy metals. The implantation process allows us to alter both the structure and composition of the surface. The authors have shown that P implantation (100 keV) into Fe-Cr alloys is responsible for a significant change in corrosion behavior relative to the unimplanted alloy. Their results tend to confirm Hashimoto's hypothesis that P stimulates the initial dissolution of the alloy and leads to an enrichment of Cr on the surface, which improves passivity. Based on these results, the authors have refined this model substantially to include effects of P content. Their model incorporates the P concentration, Cr concentration and nature of the electrolyte to explain the corrosion of these P implanted Fe-Cr alloys. This work indicates that, while there is some effect of structure on corrosion, the primary influence is that of chemical composition.

51159 The effect of pH on the nature and formation of the passive film on amorphous Ni-P-Cr alloys. Helfand, M.A. (State Univ. of New York, Stony Brook, NY (USA). Dept. of Materials Science and Engineering); Clayton, C.R.; Sorensen, N.R.; Diegle, R.B. pp. 478 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC04-76DP00789. (CONF-8910107--: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The presence of P in transition-metal metalloid glasses has been observed to promote the development of very stable, protective passive films. Furthermore, the presence of both Cr and P together result in increased passive film stability. In order to investigate the role of P in the formation of passive films and any possible synergistic effects between Cr and P in promoting the formation of highly corrosion resistant passive films four alloy systems where chosen for study; Ni-20P, Ni-20P-3Cr, Ni-20P-6Cr and Ni-20P-10Cr (at.%). All the alloys were prepared by melt spinning and the glassy structure was confirmed by x-ray and electron diffraction, and by transmission electron microscopy. This paper reports the anodic behavior and the composition of the passive film formed examined on all four of these alloys in O.2N SO_4 of varying pH using electrochemical techniques and surface analysis (XPS and AES).

51160 Electronic transport in thermally grown Cr_2O_3. Park, J.H. (Argonne National Laboratory, IL (USA)); Natesan, K. *Oxidation of Metals (USA)*, 33(1-2): 31-54 (Feb 1990). DOE Contract W-31-109-ENG-38.

Electrical conductivity of thermally grown Cr_2O_3 has been measured as a function of temperature and over a range of oxygen

partial pressures from that of air to that of the Cr/Cr_2O_3 equilibrium. The conductivity showed p-type behavior over the range of the present investigation. At temperatures above 1,000°C, the conductivity values were independent of oxygen partial pressure and indicated intrinsic semiconductor behavior. The oxidation kinetics of Cr were determined by measuring the electrical conductivity and electromotive force across the oxide layer at 875°C. The result agreed well with the oxidation data obtained in thermogravimetric tests.

51161 Analysis of decarburization of hypereutectoid Fe-C alloys and its application in evaluating the processing steps used to make Damascus steel swords. Verhoeven, John D. (Iowa State Univ. of Science and Technology, Ames, IA (USA). Dept. of Materials Science and Engineering). *Materials Characterization (USA),* 25(2): 221-239 (Sep 1990).

The decarburization of a hypereutectoid Fe-C alloy at temperatures below the solubility limit of cementite (the A_{cm} composition of the alloy) and above the pearlite temperature will produce two distinct diffusion layers at the decarburized surface. The first layer will be pure ferrite and the second layer will be austenite which will have transformed into pearlite on cooling (or martensite in quenched samples). A mathematical solution is presented for diffusion control of this decarburization process and it is shown that the relative thickness of the two layers is a fairly strong function of the temperature at which the decarburization is carried out. Damascus swords have a decarburized fold down their back side and this analysis is applied to one Damascus blade. It is demonstrated that metallographic analysis of the fold region allows an estimation of the forging temperature and the forging time for this blade.

51162 Effect of internal oxidation pretreatments and Si contamination on oxide-scale growth and spalling. Hou, P.Y. (Lawrence Berkeley Laboratory, CA (USA)); Stringer, J. *Oxidation of Metals (USA),* 33(5-6): 357-369 (Jun 1990). DOE Contract AC03-76SF00098.

Internal oxidation pretreatments carried out in quartz capsule with a Rhines pack were found to have a profound effect on the subsequent oxidation behavior of alloys. Specimens of Co-15 wt.% Cr, Co-25 wt.% Cr, Ni-25 wt.% Cr, and Ni-25 wt.% Cr-1 wt.% Al were tested at 1,100°C after pre-oxidation treatments. Even without the development of internal oxide particles, pretreated binary CoCr and NiCr alloys oxidized with significantly lower rates. Selective oxidation of chromium was observed on the non-Cr_2O_3-forming Co-base alloys, whereas on the Cr_2O_3-forming Ni-base alloys, elimination of base-metal oxide, reduction in the Cr_2O_3 growth rate, and better scale adhesion were found.

51163 The effect of yttrium on scale formation and breakdown of Fe-Cr-Al in mixed gas. Kung, Sicheng (Universal Energy Systems, Dayton, OH (USA)); Srinivasan, V. *Oxidation of Metals (USA),* 33(5-6): 481-508 (Jun 1990).

The effects of 1 wt.% yttrium addition to an iron-base model alloy, Fe-25Cr-6Al, on the scale formation and breakdown mechanisms in a mixed gas at temperatures 500-700°C were studied. In this environment, the equilibrium gas contained sulfur and oxygen at high and low vapor pressures, respectively. During the exposure, the formation of an alumina scale was favored kinetically on the surfaces of the alloys. The oxide scale formed on the base (Y-free) alloy had a fine-grained structure which exhibited excellent sulfidation/oxidation resistance. Based on thermodynamic calculations, the probable phases forming on the alloy surface in the oxidizing/sulfidizing environment were predicted, and a qualitative model for the corrosion mechanisms was proposed.

51164 Phonon dispersion and Kohn anomalies in $Cu_{0.84}Al_{0.16}$. Chou, H. (Physics Department, Brookhaven National Laboratory, Upton, NY (USA)); Shapiro, S.M.; Moss, S.C.; Mostoller, M. *Physical Review, B: Condensed Matter (USA),* 42(1): 500-507 (1 Jul 1990). DOE Contract AC02-76CH00016 ;AC05-84OR21400.

Motivated by the observation of x-ray diffuse satellites, attributed to screening singularities associated with parallel flat sections of the Fermi surface (in analogy with Kohn anomalies), we have made detailed measurements of phonon frequencies along all high-symmetry directions on a large single crystal of $Cu_{0.84}Al_{0.16}$ at room temperature. Phonon frequencies were ascertained to better than ±0.03 meV. Interatomic force constants and a vibrational density of states were calculated by performing a Born–von Karman analysis on the complete set of phonon dispersion curves. Near the zone boundaries phonon energies are significantly lower than the corresponding phonons in pure Cu. This is attributed to mode repulsion from high-frequency localized vibrational modes of the Al atom in the Cu host lattice. No strong anomaly, either in the phonon dispersion itself or in the derivative, was observed near the expected wave vector $q=2k_F$. The absence of Kohn anomalies in the present system could be due either to a smeared-out Fermi surface or to the possibility that the electron-electron interaction that screens the interionic potential is not the dominant interaction in the system; i.e., the existence of Kohn anomalies in these alloys may depend mainly on the details of the electron-phonon interaction.

51165 Thermodynamic properties of dilute *Cu*Cr alloys. Sacramento, P.D. (Department of Physics, Temple University, Philadelphia, Pennsylvania 19122 (USA)); Schlottmann, P. *Physical Review, B: Condensed Matter (USA),* 42(1): 743-746 (1 Jul 1990). DOE Contract FG02-87ER45333.

Exact theoretical results for the *n*-channel Kondo model are used to interpret experimental data for the specific heat, susceptibility, and resistivity of dilute *Cu*Cr alloys. Reasonable agreement is obtained for $S=n/2=5/2$, $T_K=1.5$ K, and g factor 2, except for the susceptibility at low temperature, where interactions between impurities appear to be relevant.

51166 Combined neutron and x-ray powder diffraction study of $Fe_{0.50}Co_{0.48}V_{0.02}$. Williams, A. (Los Alamos National Laboratory, Los Alamos, NM (USA)); Kwei, G.H.; Ortiz, A.T.; Karnowski, M.; Warburton, W.K. *Journal of Materials Research (USA),* 5(6): 1197-1200 (Jun 1990).

The large number of constituent elements and high symmetry of the ordered Fe-Co-V alloys make a complete solution of its structure impossible from a single diffraction experiment. We have carried out a Rietveld refinement of the site occupancies for a partially ordered Fe-Co-V alloy using both neutron and anomalous dispersion x-ray powder diffraction data in order to obtain a complete crystallographic solution to its structure. Contrary to previous assumptions that V occupies both sites randomly or magnetic and Moessbauer studies that suggest that V has a site preference for the Fe sublattice, we find that the V dopant preferentially occupies the Co sites.

51167 Correlation between structure, energy, and ideal cleavage fracture for symmetrical grain boundaries in FCC metals. Wolf, D. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)). *Journal of Materials Research (USA),* 5(8): 1708-1730 (Aug 1990). DOE Contract W-31109-ENG-38.

The misorientation phase space for symmetrical grain boundaries is explored by means of atomistic computer simulations, and the relationship between the tilt and twist boundaries in this three-parameter phase space is elucidated. The so-called random-boundary model (in which the interactions of atoms across the interface are assumed to be entirely random) is further developed to include relaxation of the interplanar spacings away from the grain boundary. This model is shown to include fully relaxed free surfaces naturally, thus permitting a direct comparison of the physical properties of grain boundaries and free surfaces, and hence the determination of ideal cleavage-fracture energies of grain boundaries. An extensive comparison with computer-simulation results for symmetrical tilt and twist boundaries shows that the random-boundary model also provides a good description of the overall structure-energy correlation for both low- and high-angle tilt and twist boundaries. Finally, the role of the interplanar spacing parallel to the grain boundary in both the grain-boundary and cleavage-fracture energies is elucidated.

51168 High temperature ultrasonic testing of materials for internal flaws. Kupperman, D.S.; Linzer, M. To Dept. of Energy, Washington, DC (USA). USA Patent 4,898,034/A/. 6 Feb 1990. Filed date 23 Aug 1988. USA Patent patents application 7-235.078. Int. Cl. G01N 29/00. 8p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes an apparatus disclosed for nondestructive evaluation of defects in hot materials, such as metals and ceramics, by sonic signals. It comprises: a zirconia buffer in contact with a hot material being tested, a liquid couplant of borax in contact with the zirconia buffer and the hot material to be tested, a transmitter mounted on the zirconia buffer sending sonic signals through the buffer and couplant into the hot material, and a receiver mounted on the zirconia buffer receiving sonic signals reflected from within the hot material through the couplant and the buffer.

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Refer also to citation(s) 50332, 50656, 50892, 51038, 51039, 51040, 51041, 51104, 51117, 51118, 51126, 51129, 51138, 51154, 51155, 51156, 51168, 51351, 51389, 51419, 51420, 51438, 51444, 51461, 51473, 51578, 51600, 51609, 51686, 51884, 52005, 52291, 52295, 52310, 52312, 52313, 52314, 52315, 52351

51169 (AD-A-223494/6/XAB) **Synthesis and property evaluation of $YBa_2Cu_3O_{6+x}$ superconductors. Interim report, October 1988-September 1989.** Rao, A.S.; Arora, O.P. David Taylor Research Center, Bethesda, MD (USA). Ship Materials Engineering Dept. Jun 1990. 28p. (DTRC-SME-89/100). Source: NTIS, PC A03/MF A01.

Superconducting $YBa_2Cu_3O_{6+x}$ powders were synthesized for obtaining fine particles of uniform size using solid state chemical reaction, coprecipitation and copper oxide coating with yttrium and barium oxalate or carbonate methods. The powders obtained from all three different routes showed superconductivity; however, the Tc values for the as synthesized powders via. the solid state and copper oxide coating methods were 90 K and the oxalate and carbonate derived powders was 80 and 60 K respectively. Recalcination and annealing the samples in oxygen had very little effect on the Tc value, but the sample resistance above Tc appears to decrease slightly.

51170 (BNL-45207) **Microstructures and dc critical currents in textured Y-Ba-Cu-oxides.** Orehotsky, J. (Brookhaven National Lab., Upton, NY (USA)); Wiesmann, H.; Moodenbaugh, A.R.; Suenaga, M.; Wang, H.-G.; Herman, H. Brookhaven National Lab., Upton, NY (USA). 24 Sep 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900944-10: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000895. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Sintered bars of Y-Ba-Cu oxide were partially melted using a quartz halogen lamp zone heating apparatus. The resulting multiphase samples showed varying degrees of "melt texturing." It was found that the addition of YBa_2CuO_5 powders to the sintered $YBa_2Cu_3O_7$ prior to the zone melting process enhanced the growth of large textured grains. The best value of the critical current density was $\sim 10^3$ A/cm^2 at 1.0 T and 77 K for the starting composition of $YBa_2Cu_3O_7 \bullet (0.2)Y_2BaCuO_5$. 11 refs., 5 figs.

51171 (BNL-45208) **A theoretical comparison of the effects of the shape of the pinning potential and a distribution of pinning energies on the apparent pinning energy as measured by magnetic flux creep.** Welch, D.O. Brookhaven National Lab., Upton, NY (USA). 24 Sep 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900944-12: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000896. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In the analysis of magnetic flux creep experiments it is assumed that, at a given temperature, the pinning energy which must be overcome by thermal activation depends on the magnetic induction and its gradient by $U(B,\nabla B) \cong U_p(B)[1-\nabla B/\nabla B_{max}]^n$ where U_p is the pinning well depth and ∇B_{max} corresponds to the critical current density with no thermal activation. Customarily, n is assumed to be unity and any unusual temperature dependence of U_p is then ascribed to a distribution of well depths. However, realistic assumptions about the shape of the pinning potential yield $3/2 \lesssim n \lesssim 2$, which yields an apparent distribution of well depths in the conventional analysis. Simple models will be used to illustrate the characteristics of these two quite different origins for the apparent temperature dependence of well depth obtained from magnetic flux creep rates. 13 refs., 8 figs.

51172 (BNL-45227) **Observations of vortex structure in $YBa_2Cu_3O_7$.** Muller, H.; Wiesmann, H.J.; Suenaga, M. Brookhaven National Lab., Upton, NY (USA). 24 Sep 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900944-11: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000900. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The remnant magnetic flux distribution in a single crystal and a sintered polycrystal was examined using the magnetic particle decoration technique. The single crystal, which was heavily twinned, showed only local order in the flux lattice. This was probably due to lattice distortions caused by interaction between twin boundaries and fluxons. In the polycrystal, flux pinning effectiveness was seen to vary significantly between grains, depending on size and orientation. Grains with the c axis nearly perpendicular to the applied magnetic field were most effective at pinning flux. Some features of the decoration patterns implied that the flux distribution was influenced by more than just the grains at the sample surface. 7 refs., 6 figs.

51173 (CONF-900527-4) **Critical current densities in neutron irradiated high-T_c single crystals.** Weber, H.W. (Atominstitut der Oesterreichischen Universitaeten, Vienna (Austria)); Sauerzopf, F.M.; Wiesinger, H.P.; Kritscha, W.; Crabtree, G.W.; Liu, J.Z.; Frischherz, M.C.; Kirk, M.A. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Contract 6837. From ICMC '90 topical symposium on high temperature superconductors: materials aspects; Garmisch-Partenkirchen (Germany, F.R.); 9-11 May 1990. Order Number DE90017794. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Radiation damage and its effects on flux pinning and critical current densities in conventional superconductors have been investigated in much detail. In the case of fast neutron irradiation, the primary superconductive properties, such as the transition temperature T_c, are not affected very much at relatively low fluences ($\lesssim 10^{22}$ m^{-2}, E > 0.1 MeV) in general, but the critical current densities may either increase in low-J_c materials due to the introduction of new pinning centers, or increase because of a radiation-induced increase of the upper critical field H_{c2}, or decrease due to an unfavorable interaction with the pre-irradiation defect structure. Concerning high temperature superconductors, neutron irradiation experiments on single crystals and subsequent magnetization measurements have consistently shown a significant broadening of the hysteretic magnetization curves and, thus, provided for (intrinsic) enhancements of critical current densities J_c. Similar results on ceramics are attributed mainly to an increasing loss of weak link behavior with increasing neutron fluence. In the present contribution we will report on a systematic investigation of fast neutron irradiation effects carried out in the fluence range from 2×10^{21} to 2×10^{22}m^{-2} (E > 0.1 MeV) on two high-quality single crystals of $YBa_2Cu_3O_{7-\delta}$. Furthermore, we will present results of an irradiation experiment on a $Bi_2Sr_2CaCu_2O_8$ single crystal, which has demonstrated the feasibility of flux pinning temperatures and magnetic fields beyond the "irreversibility" line for the first time. 19 refs., 5 figs.

51174 (CONF-900643-2) **Electrical properties of high-temperature superconductors at microwave frequencies.** Lanagan, M.T.; Bohn, C.L.; Delayen, J.R.; Poeppel, R.B. Argonne National Lab., IL (USA). Jun 1989. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From IEEE international symposium on applications of ferroelectrics; Urbana, IL (USA); 6-8 Jun 1990. Order Number DE90017684. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The surface resistance of polycrystalline high-temperature superconductors are presented at microwave frequencies. Several cavities were used to span the frequency range from 100 Mhz to 26 GHz. Surface resistance was observed to increase with frequency and rf magnetic field. Potential applications are discussed in terms of the electrical properties and the ability to fabricate materials into useful geometries. 23 refs., 8 figs.

51175 (CONF-901125–1) **Reinforced ceramics employing discontinuous phases.** Becher, P.F. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 2. international ceramic science and technology congress symposium on glasses for electronic applications; Orlando, FL (USA); 12-15 Nov 1990. Order Number DE91000399. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The fracture toughness of ceramics can be improved by the incorporation of a variety of discontinuous reinforcing phases and microstructures. Observations of crack paths in these systems indicate that these reinforcing phases bridge the crack tip wake region. Recent developments in micromechanics toughening models applicable to such systems are discussed and compared with experimental observations. Because material parameters and microstructural characteristics are considered, the crack bridging models provide a means to optimize the toughening effects. 18 refs., 2 figs.

51176 (CONF-901194–3) **Heat transfer issues in the fabrication and operation of ceramic superconductors.** Hull, J.R.; Kuzay, T.M.; Poeppel, R.B. Argonne National Lab., IL (USA). [1990]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From ASME winter annual meeting; Dallas, TX (USA); 25-30 Nov 1990. Order Number DE90017832. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Problems associated with the fabrication and operation of ceramic superconductors are discussed to suggest possible contributions from the heat transfer community that could advance high-temperature superconductor technology. Specific fabrication issues include uniform temperature in sintering, speedup of directional solidification methods, uniform substrate temperatures for thin-film fabrication, and process control in most wire and tape fabrication methods. Opportunity exists for analyses and novel designs in cryostat current leads, certain insulation problems, and other applications. Use of Be as a stabilizer is suggested in order to improve cryostability at 77 K. In addition, the use of SiC and novel heat transfer mechanisms is suggested for improvement of normal-zone propagation velocity. 37 refs.

51177 (CONF-9005183–, pp. 35-42) **The measurement of single particle temperature in plasma sprays.** Fincke, J.R. (EG and G Idaho, Inc., Idaho Falls (USA)); Swank, W.D.; Bolsaitis, P.P.; Elliott, J.F. Argonne National Lab., IL (USA). [1990]. DOE Contract AC07-76ID01570. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

A measurement technique for simultaneously obtaining the size, velocity, temperature, and relative number density of particles entrained in high temperature flow fields is described. In determining the particle temperature from a two-color pyrometery technique, assumptions about the relative spectral emissivity of the particle are required. For situations in which the particle surface undergoes chemical reactions the assumption of gray body behavior is shown to introduce large temperature measurement uncertainties. Results from isolated, laser heated, single particle measurements and in-flight data from the plasma sprays of WC-Co are presented. 10 refs., 5 figs., 1 tab.

51178 (CONF-9005183–, pp. 237-242) **NDE of critical currents in high T_c superconductors.** Telschow, K.L. (EG and G Idaho, Inc., ID (USA)); O'Brien, T.K. Argonne National Lab., IL (USA). [1990]. DOE Contract AC07-76ID01570. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The use of an electromagnetic probe as a nondestructive evaluation tool for determining critical current dissipation in high T_c superconducting materials is described. The probe inductively generates a current in the superconductor that adds to the externally produced transport current. Dissipation is detected in the probe response whenever the net current in the material exceeds the critical value at the location of the probe. Results are presented for a simultaneous measurement of critical current dissipation with the contact 4-point probe DC method and the noncontacting inductive method described. Interpretation of the probe response is given in terms of the homogeneous isotropic London model. 20 refs., 3 figs.

51179 (CONF-9005183–, pp. 243-250) **Photothermal measurements of high-T_c superconductors.** Fanton, J.T. (Stanford Univ., CA (USA)); Kapitulnik, A.; Khuri-Yakub, B.T.; Kino, G.S. Argonne National Lab., IL (USA). [1990]. DOE Contract FG03-87ER13797. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The authors use a photothermal system to measure the anisotropic thermal conductivities of single-crystal high-T_c superconductors. Measurements made along the superconducting Cu-O planes exhibit a strong enhancement in thermal conductivity below T_c. They also report abrupt changes in the modulated reflectance signal at T_c that begin as much as 12 K above the transition. 10 refs., 8 figs.

51180 (CONF-9009173–1) **Growth and transport properties of Y-Ba-Cu-O/Pr-Ba-Cu-O superlattices.** Lowndes, D.H.; Norton, D.P.; Budai, J.D.; Christen, D.K.; Klabunde, C.E.; Warmack, R.J.; Pennycook, S.J. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From SPIE conference on prospects on high temperature superconducting transistors and other devices; Santa Clara, CA (USA); 30 Sep - 5 oct 1990. Order Number DE91000721. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The pulsed-laser deposition method has been used to fabricate epitaxial, nonsymmetric M(Y) x N(Pr) superlattices in which $YBa_2Cu_3O_{7-x}$ (YBCO) layers either M = 1,2,3,4,8, or 16 c-axis unit cells thick are separated by insulating $PrBa_2Cu_3O_{7-x}$ (PBCO) layers N unit cells thick (N = 1 to ~32). The zero-resistance superconducting transition temperature, T_{c0}, initially decreases rapidly with increasing PBCO layer thickness, but then saturates at T_{c0} ~ 19 K, 54 K, 71 K, or 80 K, or structures containing 1-,2-,3-, or 4-cell-thick YBCO layers, respectively. Critical current density measurements carried out on structures with 16- or 32-cell thick YBCO layers show that the magnitude of $J_c(H = 0)$ ~ 1-2 MA/cm^2, as well as the magnetic field dependence and the anisotropy of $J_c(H)$ all are in good agreement with corresponding measurements on thicker, single-layer YBCO films. Thus, there is no evidence of an enhanced $J_c(H)$ due to the multi-layered structure, for the layer thickness investigated to date. The systematic variation of T_{c0}, as a function of the YBCO and PBCO layer thickness, is discussed in light of other recent experiments and theoretical model calculations. The superlattices' structural and compositional order are characterized using x-ray diffraction, transmission electron microscopy, and scanning tunneling microscopy, and details of the pulsed-laser deposition process are reported. 42 refs., 7 figs.

51181 (CONF-9010201–1) **Gelcasting of sub-micron alumina, sialon, and silicon nitride powders.** Omatete, O.O.; Strehlow, R.A.; Walls, C.A. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 37. Sagamore army materials research conference; Plymouth, MA (USA); 1-4 Oct 1990. Order Number DE91000618. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Gelcasting is a near-net-shape forming technique that is applicable to various types of powders. It is accomplished by casting a concentrated suspension of a commercial ceramic powder in a solution of a polymerizable monomer and then polymerizing. A filled gel is formed, which is dried and processed further. Alumina, sialon, and silicon nitride parts of various geometries have been made and are described. Emphasis is placed on the unit-operations of the process. Because a requirement of the process is a castable suspension of more than 50 vol % solids loading, good dispersion is crucial. Drying, another key process, has been studied extensively. Shrinkage from the cast size occurs during drying

and further shrinkage occurs during sintering. Data on the relationship of physical properties of products to some of the more significant processing variables is discussed. Emphasis is also placed on the machinability of the dried gelled body. Because the body at this stage is quite durable, green part machining is feasible. The monomer used in the process is acrylamide, which undergoes a vinyl polymerization. Environmental, safety and hygiene issues are summarized. 9 refs., 6 figs.

51182 (DOE/ER/45170–6) **Theoretical studies on the electronic structure and properties of complex ceramic crystals and glasses: Annual progress report, July 1, 1989–June 30, 1990.** Ching, Wai-Yim. Missouri Univ., Kansas City, MO (USA). 1 Jun 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45170. Order Number DE91000595. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This annual report covers the last year of a three-year project supported by the Department of Energy that was started on July 1, 1986. Within these three years, a phenomenal amount of research results have been obtained. In the following section, Section II, we summarize the research work accomplished since July 1, 1986 as was documented in the renewal proposal. In Section III, we list additional accomplishments since the submission of the renewal proposal. Section IV contains the figures that have been referred to in Section II. In Section V, we list the scientific personnel and students that have been involved in the project. Technical papers published or submitted under the DOE support since the last annual report are documented in Section V. Because of the large number of papers published or submitted, reprint and preprint copies will be submitted separately instead of attaching in the form of appendix.

51183 (DOE/ER/45219–4) **Characterization of electrically conducting oxides: [Progress report], January 16, 1989–December 31, 1989.** Anderson, H.U.; Sparlin, D.M. Missouri Univ., Rolla, MO (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER45219. Order Number DE91000596. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report discusses some of the highlights and publications of this years work. Listed below are the areas of interest and progress within the program: The studies of the $Ba_2YCu_3O_{7-x}$ system have shown that the conduction processes (metallic or small polaron) have little temperature dependence and are almost entirely a function of oxygen stoichiometry. The substitution of 10 to 20 m% Ca and Co into $LaCrO_3$ has enabled the system to be sintered to >95% TD at 1400°C without deterioration of either the electrical conductivity or high temperature stability of the resulting dense ceramics. An elucidation of the structure of the high temperature (1400°C) phases of La substitute $SrTiO_3$ has demonstrated our abilities to determine small changes in structure as well as to determine cation defect concentrations using x-ray powder diffraction methods. In this study we were able to show that the oxidized state of $Sr_{1-x}La_xTiO_3$ contained cation vacancies. The studies in the $Y_{1-x}Ca_xCrO_3$ system also are yielding some important results. They are showing that this oxide system is more stable toward reduction than $LaCrO_3$. The construction of dual high temperature controlled atmosphere dilatometer has been completed. An effective-medium theory of hopping transport in binary systems is explaining the conductivity changes that occur when Mn is substituted into $LaCrO_3$.

51184 (EGG–10617-2017) **Effects of x-ray radiation on the magnetization of high T_c superconductors.** Artuso, J. (EG and G, Inc., Goleta, CA (USA). Energy Measurements Group); Franks, L.; Hull, K.; Symko, O.G. EG and G, Inc., Goleta, CA (USA). Energy Measurements Group. [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-900944–3: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000129. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Experimental results are presented on the effects of x-ray radiation on superconducting samples of polycrystalline YBaCuO and BiSrCaCuO. The radiation effects are detected by changes of the magnetization of the sample using a SQUID magnetometer. In the presence of radiation, the changes in magnetization correspond to release of trapped flux, fluxon destruction, and to low frequency noise due to flux flow. 3 refs., 4 figs.

51185 (IS-T–1448) **Magnetic and thermal properties of high T_c superconductors.** Lee, Wonchoon. Ames Lab., IA (USA). 21 Sep 1990. 138p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000743. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Measurements of the normal state magnetic susceptibility $\chi(T)$ of $YBa_2Cu_3O_7$, $Bi_{1.8}Pb_{0.2}Sr_2CaCu_2O_{8+\delta}$, and $Bi_{2-x}Pb_xSr_2Ca_2Cu_3O_{10+\delta}$ ($x \approx 0.2$ and 0.25) were carried out. All $\chi(T)$ data show negative curvature below $\sim 2T_c$. The data for $YBa_2Cu_3O_7$ are in excellent agreement with a new calculation of the superconducting fluctuation diamagnetism. From the analysis, we infer s-wave pairing and microscopic parameters are obtained. For $\chi(T)$ of $YBa_2Cu_3O_7$, part of the negative curvature is inferred to arise from the normal state background. We find a strong temperature dependent anisotropy $\delta\chi \equiv \chi_c - \chi_{ab}$ and estimate the normal state spin contributions to $\chi(T)$. The heat capacity C(T) of $YBa_2Cu_3O_7$ is reported for $0.4\ K < T < 400\ K$ in zero and 70 kG magnetic fields. In addition to the feature associated with the onset of the superconductivity at T_c, two anomalies in C(T) were observed near 74 K and 330 K, with another possible anomaly near 102 K; the temperatures at which they occur correlate with anomalies in $\chi(T)$ and ultransonic measurements. The occurrence of the anomaly at $\simeq$ 330 K is found to be sample-dependent. The influences of a magnetic field and the thermal and/or magnetic field treatment history dependence of a pellet sample on C(T), the entropy and the influence of superconducting fluctuations on C(T) near T_c, and the possible source of the observed intrinsic nonzero $\gamma(0)$ at low T are discussed.

51186 (LA-UR–90-3160) **Microwave sintering of nanocrystalline TiO_2.** Eastman, J.A. (Argonne National Lab., IL (USA)); Liao, Y.X.; Sickafus, K.E.; Katz, J.D.; Boeke, S.G.; Blake, R.D.; Evans, C.R.; Schwarz, R.B. Los Alamos National Lab., NM (USA). Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36 ;W-31109-ENG-38. (CONF-900466–89: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE91000375. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Nanocrystalline TiO_2 compacts having initial approximate mean grain sizes of 14 nm and approximate green densities of 70% of theoretical were sintered by short-time exposure in a 2.45 GHz microwave cavity to maximum temperatures of 800, 1000 or 1200°C. Sample densities were measured before and after exposure to microwaves using Archimede's method. Transmission electron microscopy and x-ray diffraction were utilized to monitor grain growth and phase changes. Rutherford backscattering was used to monitor any changes in oxygen stoichiometry. The results of this study indicate that enhanced densification behavior is obtained for microwave sintered samples relative to samples sintered using conventional pressureless-sintering techniques. 11 refs., 3 figs.

51187 (LA-UR–90-3268) **Microwave properties of HTS [high temperature superconductor] films.** Cooke, D.W. (Los Alamos National Lab., NM (USA)); Arendt, P.N.; Gray, E.R.; Muenchausen, R.E.; Bennett, B.L.; Foltyn, S.R.; Estler, R.C.; Wu, X.D.; Reeves, G.A.; Elliott, N.E.; Brown, D.R.; Portis, A.M.; Taber, R.C.; Mogro-Campero, A. Los Alamos National Lab., NM (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36 ;AC03-76SF00098. (CONF-901105–12: Fall meeting of the Materials Research Society, Boston, MA (USA), 24 Nov - 1 dec 1990). Order Number DE91000211. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

High-frequency applications of high-temperature superconductors generally fall into two categories: devices that require low values of surface resistance R_s in ambient surface magnetic fields H_{rf}, and devices that require low R_s in modest fields. Moreover, many applications can be realized with small-surface-area films whereas others require larger areas-radiofrequency (rf) cavities, for example. Regardless of the application, the potential of HTS films is predicated on satisfying one or both of the above-stated requirements. We have measured the surface resistance of small-area (1 cm^2) and large-area (6.5 cm^2) $YBa_2Cu_3O_7$ (YBCO) films that have been laser ablated onto $LaA\ell O_3$ substrates, large-area (5.1 cm^2) YBCO films that have been e-beam deposited onto $LaA\ell O_3$, and large-area (11.4 cm^2) Tℓ-based films that have been magnetron

sputtered onto metallic substrates. The best R_s values are obtained from the 1-cm^2 laser-ablated films; they are 40 $\mu\Omega$ and 340 $\mu\Omega$ at 4 K and 77 K, respectively ($\omega/2\pi$ = 10 GHz). Comparable values for Cu are 6 and 13 mΩ, respectively. Large-area Tℓ-based films yield typical R_s values of 4 mΩ and 14 mΩ at 4 K and 77 K, respectively ($\omega/2\pi$ = 18 GHz). The dependence of R_s on H_{rf} for these films indicates that surface fields as large as 55 Oe can be achieved with R_s increasing only by a factor of 10. This field dependence is associated with c-axis texturing.

51188 (LBL–26455, pp. 53-54) **Work in progress.** Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Direct bolometric absorptivity measurements of high-T_c superconductors will be perfected so as to provide high accuracy over a wide far-infrared spectral range from ~3 to 1,200 cm^{-1}. The refurbishment of the spectrometer begun in 1988 will be completed. Attention will be given to errors arising from multiple thermal time constants, absolute normalization, standing waves, etc. The search for information about energy-relaxation mechanisms in molecule-metal vibrational modes will be continued using their novel infrared-emission apparatus. The linewidth of the carbon-metal mode of CO on Ni(100) will be measured as a function of temperature. The one data point available is consistent with theories of multiphonon relaxation. A study of the temperature dependence could confirm the only known example of this mechanism, which is predicted to be of general importance. The search for the far-infrared optical phason mode in the charge-density-wave compounds TaS_3 and $K_{0.3}$ MoO_3 will be continued.

51189 (LBL–26455, pp. 61-62) **Symmetry breaking and nonlinear electrodynamics in the ceramic superconductor $YBa_2Cu_3O_7$.** Jeffries, C.; Lam, Q.H.; Kim, Y.; Bourne, L.C.; Zettl, A. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

For bulk samples of the ceramic superconductor $YBa_2Cu_3O_7$ in a radiofrequency magnetic field and in a dc magnetic field H_0, the authors observe novel non-linear behavior, including very high-order odd-harmonic generation if $H_0 = 0$. If $H_0 \neq 0$, there is additional even-harmonic generation. The even-harmonic power displays a very sharp dip at $H_0 \sim 0$, of width ~ 100 μG. This and related behavior can be semiquantitatively understood by modeling the system as a suitably averaged collection of flux-quantized supercurrent loops containing Josephson junctions.

51190 (ORNL/FTR–3761) **[Lattice defects in ionic materials]: Foreign trip report, September 1–16, 1990.** Chen, Yok. Oak Ridge National Lab., TN (USA). 1 Oct 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000686. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler chaired a session at the Sixth Europhysical Conference on Lattice Defects in Ionic Materials and coauthored two contributed poster papers entitled, "Intrinsic Defects in Stabilized Zirconia Produced by Thermochemical Reduction or Irradiation" and "The [H-Ca$^+$] Defect in Thermochemically Reduced CaO: Static and Dynamical EPR Study." He visited the University of Paris, the University of Zaragoza, the University of Madrid Complutense, and the Junta de Energia Nuclear.

51191 (ORNL/FTR–3763) **[High T_c superconductivity]: Foreign trip report, April 12, 1990–June 8, 1990.** Rasolt, M. Oak Ridge National Lab., TN (USA). 2 Oct 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000692. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A detailed description of the research conducted at the University of Paris at Orsay and the International Meeting on High-T_cSuperconductivity, organized by the traveler, H. Schultz from Orsay, and D. M. Newns from IBM, is presented. Particular emphasis is placed on the collaboration with F. Perrot of the Centre Europeen de Calcul Atomique et Moleculaire. In addition, descriptions of the different scientific interactions and information obtained and implications of this scientific exchange on the research conducted in the Solid State Division of ORNL are made.

51192 (PNC-TN–8410-90-018) **A study on fabrication technology of ceramic overpack: A conceptual design and fabrication of a full-scale ceramic overpack.** Teshima, T. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works); Ishikawa, H.; Sasaki, N.; Karita, Y.; Katsumoto, K. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). Mar 1990. 15p. Order Number DE91713049. Source: NTIS (US Sales Only), PC A03/MF A01.

The conceptual design and fabrication test of a full-scale ceramic overpack were performed from the viewpoint of structural barriers as a part of program to evaluate their potential use as overpack under conditions of deep geological disposal. Materials investigated were porcelain (used for insulators) and Al_2O_3 with high purity of 99.7 %. The selected design consisted of a cylindrical body with hemispherical heads at each end. The design thickness of overpack is the sum of the structural thickness and corrosion allowance. The thickness required to resist the lithostatic pressure was estimated by the basic cylinder buckling formulas and finite element stress analyses in both case of uniform and non-uniform external pressure conditions. These analyses showed that structural thickness of 119 mm was necessary for overpack of porcelain and 40 mm for Al_2O_3 under the predicted maximum uniform pressure. In addition, fracture probability of delayed failure, one of significant degradation mode, was estimated for overpack of porcelain. A full-scale overpack of porcelain, of dimensions 800 mm outer diameter x 2200 mm length x 150 mm wall thickness, was fabricated under the ordinary level of fabrication technology. (author).

51193 (SAND–90-2203C) **In-situ pore structure analysis during aging and drying of gels.** Smith, D.M. (New Mexico Univ., Albuquerque, NM (USA). Center for Micro-Engineered Ceramics); Davis, P.J.; Brinker, C.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900466–86: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE91000044. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The use of NMR relaxation measurements for the in-situ study of pore structure evolution during gel aging and drying is illustrated. The change in the pore size distribution and surface area of other wet and dried gels is examined as a function of aging conditions including temporal aging, thermal aging, changing pH, and changing pore fluid. The effect of pore fluid pH on dissolution/reprecipitation in ordered packings of monodisperse silica spheres is also examined as a model system for particulate gels. As expected, the pore size distribution narrows with increasing time of treatment in high pH pore fluids. Interpretation of high pH results for the wet state is complicated by a microporous layer which forms on colloidal silica resulting in significantly large wet surface area as compared to the final dried material. Narrowing of the pore size distribution, which is of interest for maximizing drying rates, is maximized in the least time by using either high pH or repeated ethanol washes for the base-catalyzed gel (B2) used. 21 refs., 10 figs.

51194 (SAND–90-2333C) **Thin film processing and device fabrication in the Tl-Ca-Ba-Cu-O system.** Martens, J.S.; Ginley, D.S.; Zipperian, T.E.; Hietala, V.M.; Tigges, C.P. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9009100–1: SPIE's technical symposium on microelectronic processing integration and exhibition as part of SPIE's thematic applied science and engineering series, Santa Clara, CA (USA), 30 Sep - 5 oct 1990). Order Number DE91000764. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An obvious group of applications for high temperature superconducting (HTS) materials is microwave and millimeter wave circuitry. Besides low loss, unique features of these materials, such as flux flow, can be exploited. We have been concentrating on the Tl-Ca-Ba-Cu-O family of materials. The film growth techniques, lithographic processing methods and characteristics of several devices we have developed will be presented. These devices include a flux flow-based transistor with demonstrated operation at frequencies above 35 GHz, real gain in a 50 Ω system and potentially

useful non-linearities and impedance levels. A number of passive microwave components are under investigation to form a more complete HTS microwave technology group. 16 refs., 6 figs.

51195 (UCRL-JC-103668) **Reactive sputtering of molybdenum-oxide gradient-index filters.** Jankowski, A.F.; Schrawyer, L.R.; Perry, P.L. Lawrence Livermore National Lab., CA (USA). Aug 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901035--4: 37. national American Vacuum Society symposium, Toronto (Canada), 8-12 Oct 1990). Order Number DE91000939. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Molybdenum-oxide gradient-index films are produced by reactive sputter deposition. A molybdenum metal target is sputtered continuously with an argon-oxygen gas mixture. For each target power used, a reproducible oxide composition and corresponding refractive index result. Repetitive variation of applied target power is used to produce a structure composed of discrete layers of preselect stoichiometry. The systematic control of a single process parameter, target power, simplifies the fabrication of molybdenum-oxide rugate filters. 7 refs., 6 figs.

51196 (UCRL-JC-105046) **Processing parameters and kinetics of bromination and chlorination in the $YBa_2Cu_3O_{6+x}$ system.** Radousky, H.B. (Lawrence Livermore National Lab., CA (USA)); Glass, R.S.; Back, D.; Chin, A.H.; Fluss, M.J.; Liu, J.Z.; Mosly, W.D.; Klavins, P.; Shelton, R.N. Lawrence Livermore National Lab., CA (USA). Sep 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900944--5: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000420. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The introduction of halogens such as Cl_2, Br_2 can restore 90 K superconductivity to oxygen deficient $YBa_2Cu_3O_{6+x}$. This is potentially important for applications to thin film devices due to the low processing temperatures required relative to reprocessing with oxygen. Low temperature 260°C and short time (>5 minute) bromination has been shown to convert initially insulting $YBa_2Cu_3O_{6.2}$ powder to a high temperature superconductor with properties similar to the standard O_7 material. This process has now been extended to single crystals as well, but with somewhat different processing parameters. Thermal gravimetric analysis (TGA) coupled with mass spectrometry indicates that the Br becomes strongly bonded, with no release of Br observed in taking powder samples to 1000°C in flowing forming gas ($2\%H_2/98\%N_2$). The reaction has also been found to be highly exothermic for both Br and Cl treatments, which is consistent with the strong bonding of the bromine discussed above.

51197 (UCRL-JC-106066) **Shock compaction of high-T_c superconductors.** Weir, S.T. (Lawrence Livermore National Lab., CA (USA)); Nellis, W.J.; McCandless, P.C.; Brocious, W.F.; Seaman, C.L.; Early, E.A.; Maple, M.B.; Kramer, M.J.; Syono, Y.; Kikuchi, M. Lawrence Livermore National Lab., CA (USA). Sep 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48 ;W-7405-ENG-82. (CONF-900818--6: International conference on shock wave and high-strain-rate phenomena in materials, San Diego, CA (USA), 12-17 Aug 1990). Order Number DE91000786. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We present the results of shock compaction experiments on high-T_c superconductors and describe the way in which shock consolidation addresses critical problems concerning the fabrication of high J_c bulk superconductors. In particular, shock compaction experiments on $YBa_2Cu_3O_7$ show that shock-induced defects can greatly increase intragranular critical current densities. The fabrication of crystallographically aligned $Bi_2Sr_2CaCu_2O_8$ samples by shock-compaction is also described. These experiments demonstrate the potential of the shock consolidation method as a means for fabricating bulk high-T_c superconductors having high critical current densities.

51198 **Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171.** Schaefer, D.W. (Sandia National Lab., Albuquerque, NM (US)); Mark, J.E. 431p. Materials Research Society, Pittsburgh, PA (USA) (1990). (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This book discusses the development of polymeric materials over the last 30 years. The chemist's ability to manipulate structure and tailor the properties of organic materials for specific applications is presented. The phenomenal success of polymer chemistry is addressed. The need for a research base in multiphase polymeric materials similar to that which underlies single-phase organics is examined.

51199 **Structure of microphase-separated silica/siloxane molecular composites.** Schaefer, D.W. (Sandia National Lab., NM (US)); Mark, J.E.; McCarthy, D.; Jian, L.; Sun, C.C.; Farago, B. pp. 57-64 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

In this paper, the structure of several classes of silica/siloxane molecular composites is investigated using small-angle x-ray and neutron scattering. These filled elastomers can be prepared through different synthetic protocols leading to a range of fillers including particulates with both rough and smooth surfaces, particulates with dispersed interfaces, and polymeric networks. The authors find examples of bicontinuous filler phases attributed to phase separation via spinodal decomposition. *In-situ* kinetic studies of particulate fillers show that the precipitate does not develop by conventional nucleation-and-growth. They see no evidence of growth by ripening whereby large particles grow by consumption of small particles. Rather, there appears to be a limiting size set by the elastomer network itself. Phase separation develops by continuous nucleation of particles and subsequent growth to the limiting size. Studies of polymer-toughened glasses are reported.

51200 **Critical review of phase equilibria in the Al_2O_3-SiO_2 system.** Pask, J.A. (Materials and Chemical Sciences Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA (US)). pp. 1-14 of Mullite and mullite matrix composites: Volume 6. Somiya, S.; Davis, R.F.; Pask, J.A. American Ceramic Society Inc., Columbus, OH (USA) (1990). pp. 649 (CONF-871189--: 1. international conference on mullite, Tokyo (Japan), 9-10 Nov 1987).

Many phase equilibria studies have been made of the Al_2O_3-SiO_2 binary system. Two controversial areas have emerged: nature of the melting and the nature of the solid solution range of mullite. Mullite has been reported to melt incongruently and also congruently. It is shown that this difference is associated with the presence of absence of αAl_2O_3 nuclei which assist in determining the position of the αAl_2O_3 liquidus. The stable solid solution range is obtained when processing conditions result in homogenization of the starting materials on an atomic or molecular level; for example a 3:2 mullite composition forms a single phase mullite microstructure. When the mixture is prepared under conditions resulting in non-homogeneity, a two-phase microstructure consisting of mullite with a higher $A1_2O_3$ content and a liquid phase is formed.

51201 **The atomic geometry of the reconstructed (001) surface of the rutile phase of SnO_2.** Duke, C.B. (Molecular Science Research Center, Batelle Pacific Northwest Lab., Richland, WA (US)); Thompson, M.R. pp. 235-240 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

The tight-binding total energy formalism developed for tetrahedrally coordinated compound semiconductors has been extended to rutile-structure oxides and applied to calculate the surface atomic geometry and electronic structure of SnO_2 (001). Two stable structures, separated by an energy barrier, are found. The first consists of slightly relaxed surface geometry with the top layer oxygen atoms relaxed outward by approximately 0.12A, and cations inward by 0.25A. The second geometry is a more massively reconstructed surface in which the four- coordinate surface Sn atoms attain highly distorted tetrahedral coordination.

51202 Electrodeposition of Cr-NbC composites from fused salt electrolyte. Varma, R. (Argonne National Lab., IL (USA)); Hope, G.; Saulz, R. pp. 359-360 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-31-109-ENG-38. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Metal matrix composites are generally formed from the molten metal, or by sintering a powdered mixture. The purpose of this investigation has been to study the incorporation of refractor ceramic particulates into chromium metal matrix during electrodeposition of the metal from LiCl-KCl (58-42 mo1%) eutectic-CrC_2 melt containing dispersion of fine ceramic particulates. In particular, the percent-inclusions (or loading) of NbC particulates in the Cr-NbC composite electroplates has been determined as a function of current density.

51203 Atomic scale structure of twin boundary in Y-Ba-Cu-O superconductors. Zhu, Y. (Dept. of Applied Science, Brookhaven National Lab., Upton NY (US)); Suenaga, M.; Xu, Y.; Kawasaki, M. pp. 413-418 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

High resolution electron microscopy of the twin boundary layers in $YBa_2(Cu_{1-x}M_x)_3O_{7-\delta}$ for x = 0 and 0.02 and M = Zn, Fe and Al show that the boundary widths are ~ 1 nm for the pure and the Zn substituted $YBa_2Cu_3O_7$, 2.5~3 nm for the Fe and Al substituted oxide. It has been found that the lattice plane is shifted across the twin boundary by $(1/3 \sim 1/2) \cdot 2d_{(110)}$ along the boundary. The broadening of the layer for the cases of Fe and Al is also thought to be associated with a reduction of the twin boundary energy, which also leads to an increased twin density.

51204 Creep of Hot-Pressed SIC Whisker Reinforced Mullite. Nixon, R.D. (North Carolina State Univ., Dept. of Materials Science and Engineering, Raleigh, NC (US)); Chevacharoenkul, S.; Davis, R.F.; Tiegs, T.N. pp. 579-604 of Mullite and mullite matrix composites. Somiya, S.; Davis, R.F.; Pask, J.A. American Ceramic Society Inc., Columbus, OH (USA) (1990). pp. 649 (CONF-871189–: 1. international conference on mullite, Tokyo (Japan), 9-10 Nov 1987).

This paper reports the steady-state, constant compressive stress creep behavior of hot-pressed unreinforced and 20 vol% SiC-whisker reinforced mullite studied in Ar within the temperature and stress ranges of 1450 to 1700K and 5-220 MPa, respectively.

51205 AEM and HRTEM studies of the eutectic system zirconia-mullite. Notis, M.R. (Dept. of Materials Science and Engineering, Lehigh Univ., Bethlehem, PA (US)); Dravid, V.P.; Lyman, C.E. pp. 528-540 of Mullite and mullite matrix composites: Volume 6. Somiya, S.; Davis, R.F.; Pask, J.A. American Ceramic Society Inc., Columbus, OH (USA) (1990). pp. 649 (CONF-871189–: 1. international conference on mullite, Tokyo (Japan), 9-10 Nov 1987).

The crystallography and morphology of twins and microcracks in the eutectic system mullite-zirconia and the associated microchemistry are discussed based on preliminary analytical and high resolution transmission electron microscopy (AEM and HRTEM) observations, in view of the tetragonal to monoclinic (t-m) transformation and the associated toughening mechanism(s). Well defined twin relationships were observed in m-ZrO_2 which were consistent with previous investigations and theoretical predictions. Highly symmetric and crystallographically well-defined microcracks were observed at the mullite-ZrO_2 interface. The microdiffraction technique was used to elucidate the crystallography of monoclinic twins and the microcracks, which were observed to be closely interrelated.

51206 Alumina/mullite interfaces in mullite/zirconia composites. Srikrishna, K. (Materials Science and Mineral Engineering, Univ. of California, Lawrence Berkeley Lab., Berkeley, CA (US)); Thomas, G.; Moya, J.S. pp. 519-527 of Mullite and mullite matrix composites: Volume 6. Somiya, S.; Davis, R.F.; Pask, J.A. American Ceramic Society Inc., Columbus, OH (USA) (1990). pp. 649 Grant DMR-83-1317239. (CONF-871189–: 1. international conference on mullite, Tokyo (Japan), 9-10 Nov 1987).

Reaction sintered mullite/zirconia composites have been characterized by conventional and high resolution electron microscopy. The interphase interfaces were for most part glass free though glass was observed at triple points with which a zirconia grain was associated. Studies of the retained alumina/mullite interface revealed it to be simi-coherent and highly stepped. No simple epitaxial relationship was observed. However, the hexagonal alumina faceted along its prismatic planes and in a manner to accommodate the low index planes of the growing mullite. This suggests that mullitization of alumina has preferred growth planes and that through additives this process can possibly be controlled.

51207 Synthesis of air sinterable lanthanum chromite powders. Chick, L.A. (Pacific Northwest Lab., Richland, WA (USA)); Bates, J.L.; Pederson, L.R. pp. 791 of Electrochemical Society 1989. Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Lanthanum chromites, as a class, comprise the state-of-the-art materials for the current interconnections in solid oxide fuel cells (SOFCs). Substitution of 16% of the La by Sr yields electrical conductivities near 27 mohs/cm at 1273 K, the nominal operating temperature of the SOFCs. The chemical stability of the lanthanum chromites both in air and in highly reducing atmospheres at SOFC operating temperatures is also an essential property required of SOFC interconnect materials. However, thermal expansion coefficients for the strontium-substituted lanthanum chromites are reported to be almost 10% below that of the fully-stabilized ZrO_2 - (8.4M%) Y_2O_3 electrolyte. Also, the lanthanum chromites are difficult to sinter to near-full density ceramics that are free of open porosity at temperatures required for SOFC fabrication. This paper reports on the development of a powder synthesis technique, called the glycine/nitrate process. This process can be used to synthesize a wide range of oxide ceramic powder compositions, including lanthanum chromites.

51208 Electrochemical vapor deposition of yttria-stabilized zirconia films. Pal, U.B. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center); Singhal, S.C. pp. 774-775 of Electrochemical Society 1989. Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Tubular solid oxide fuel cells employ yttria-stabilized zirconia as the oxygen ion conducting electrolyte at high temperatures. The authors discuss how the yttria-stabilized zirconia electrolyte films are deposited by an electrochemical vapor deposition process. In this process, the chlorides of zirconium and yttrium are volatilized and passed along with hydrogen and argon at an oxygen partial pressure of about 10^{-18} atm over one side of the porous air electrode substrate; oxygen mixed with steam at an oxygen partial pressure of about 10^{-4} atm is passed over the other side of the porous air electrode substrate. In the first stage of the reaction, designated as the chemical vapor deposition (CVD) stage, molecular diffusion of oxygen, steam and metal chlorides occurs through the porous air electrode and these react to fill the pores in the air electrode with yttria-stabilized zirconia. During the second stage of the reaction after the pores in the air electrode are closed, electrochemical transport of oxygen ion was maintaining electroneutrality occurs, through the already deposited yttria-stabilized zirconia in the pores, from the oxygen side to the chloride side. This second stage of the reaction is termed the electrochemical vapor deposition (EVD) stage. These two reaction stages viz. the CVD stage and the EVD stage, are shown.

51209 Air sinterable $LaCrO_3$ based ceramics. Koc, R. (Missouri Univ., Rolla, MO (USA). Dept. of Ceramic Engineering); Anderson, H.U. pp. 792 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

In recent years, there has been a increasing demand for materials with high electrical conductivity at elevated temperature. Such materials have applications in MHD generators, high temperature fuel cells and sensors. The perovskite-type oxides fuel cells and senors. The perovskite-type oxide $LaBO_3$ (B = Cr,Mn,Ni,Co) have attracted considerable attention because of their high melting points and high electrical conductivities. However $LaCrO_3$ even with dopants is difficult to sinter due to vapor phase transport of higher valent oxides of chromium. Typically, sintering of lanthanum chromites involves high temperatures and low oxygen partial pressures (above 1700°C and an oxygen activity below 10^{-9}. The authors recent results on $LaCrO_3$-$LaMnO_3$ have shown that the significant improvement on sinterability was achieved with at least 50% Mn substitution for Cr. However, that much Nm on the Cr site has shown to negative effects;electrical conductivity of such compounds decreased. Stability under reducing conditions was diminished. This paper describes the sintering of $LaCrO_3$ in air at temperatures below 1400°C with varying the composition without the deterioration of either the electrical conductivity or stability under reducing conditions.

51210 **Thermal expansion studies on cathode and interconnect oxide.** Srilomsak, S. (Missouri Univ., Rolla, MO (USA). Dept. of Ceramic Engineering); Tucker, D.; Koc, R.; Seward, S.; Anderson, H.U. pp. 788 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The thermal expansion coefficients (TEC's) of both $LaMnO_3$ and $LaCrO_3$ the cathode and interconnect for the high temperature solid oxide fuel cell (SOFC) are dependent upon the particular dopant used and its concentrate. In this report the dependence of the TEC's on dopant concentration is present. It is shown that the TEC of $LaCrO_3$ is less than that of stabilized zirconia and that the addition of either Al or Sr can increase the TEC to match that of zirconia. It is also shown that the addition of Mg cannot raise the TEC to match that of zirconia.

51211 **Oxygen permeability of selected refractory ceramic oxides in the range 1200-1700°C.** Courtright, E.L. (Battelle Pacific Northwest Lab., Richland, WA (USA)); Prater, J.T. pp. 757 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Many potential high temperatures structural materials, e.g. carbon/carbon, intermetallics, refractory metals, and ceramic - ceramic composites are limited by the oxidation sensitivity. The range of potential coating materials with sufficiently low oxygen permeability to act as effective oxygen barriers are very limited. This study examines several high melting point single and mixed oxides systems with different crystal structures to determine if structure or composition affects oxygen permeability.

51212 **Review of defect chemistry of $LaMnO_3$ and $LaCrO_3$.** Anderson, H.U. (Dept. of Ceramic Engineering and Physics, Univ. of Missouri-Rolla, Rolla, MO (US)); Kuo, J.H.; Sparlin, D.M. pp. 787 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The defect chemistry of both $LaMnO_3$ and $LaCrO_3$ is reviewed. Models are introduced which show that acceptor dopants increase the electrical conductivity, c, but as the oxygen activity decreases, oxygen is lost and ionic compensation by oxygen vacancies occurs, thereby reducing σ. Results from thermogravimetric, electrical conductivity, thermoelectric and X-ray diffraction experiments on $LaCrO_3$ and $LaMnO_3$ are described to illustrate the redox behavior that can be expected for these oxides. These results suggest that their behavior is predictable and can be explained by rather simple models.

51213 **Reflectivity modulation with Li_xWO_3 thin films.** Arntz, F.O. (Electro-Optics Technicology Center, Tufts University, Medford, MA (US)); Berera, G.; Goldner, R.B; Haas, T.E.; Moprel, B. pp. 879 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

One potentially improtant application for electrochromic (and other solid-state ionic)thin films is as the electrochemically-controlled reflectivity-modulated layer in smart window glass (or smart windows). In principle, smart windows can be operated in either of two modes: absorptivity modulation or reflectivity modulation. The feasibility of utilizing polycrystalline (pc) tungsten bronze films, M_xWO_3 (M = H, Li), to obtain spectrally selective reflectivity modulation has been previously demonstrated. The question addressed in this paper is to determine the upper bound for the near infrared reflectivity modulation of pc-Li_xWO_3 films.

51214 **Anodically-coloring electrochromic $LiCoO_2$ thin films.** Wei, G.; Haas, T.E.; Goldner, R.B. pp. 877 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Thin films of lithium cobalt oxide have been prepared by rf sputtering from powdered $LiCoO_2$. These films permit electrolytic removal of lithium ions upon application of an anodic voltage in a propylene carbonate-lithium perchlorate electrolyte, and the films change in color from a pale transparent bronze to a deep brown. The films can be restored to their original color by reversal of the applied voltage, reinserting the removed lithium. Repeated cycling shows good electrical reversibility. As-deposited films have a lithium to cobalt ratio of about 0.5:1, whereas films delithiated at 2.5 volts have a Li:Co ratio of 0.2:1.

51215 **Understanding process-induced microstructures in $RBa_2Cu_3O_7$.** McCallum, R.W. (Metallurgy and Ceramics Div., Ames Lab., Iowa State Univ. (US)); Kramer, M.J. *JOM (1989) (USA)*, 42(6): 26-28 (Jun 1990). DOE Contract W-7405-ENG-82.

This paper discusses how, during the processing of rare earth (R)-barium-copper-oxygen superconductors, a variety of microstructures can be induced. Many processes are designed to avoid forming some structures, but these same processes can result in other structures which degrade the superconducting properties. Because liquid phases can be detrimental, for example, low-temperature calcination is often employed. But the CO_2 gas evolved during calcination leads to the formation of a nanocrystalline microstructure which may affect superconducting properties. Textures and defects can be induced by high-temperature and high-pressure deformation.

51216 **The crystal structure of a new ternary metal-rich sulfide $Ta_{6.08}Nb_{4.92}S_4$.** Yao, Xiaoqiang (Iowa State Univ., Ames (USA)); Franzen, H.F. *Journal of Solid State Chemistry (USA)*, 86(1): 88-93 (May 1990).

The metal-rich sulfide $Ta_{6.08}Nb_{4.92}S_4$ has been prepared by high temperature techniques and characterized by means of X-ray diffraction experiments. It crystallizes in the orthorhombic space group Pnma with four formula units in the cell: a = 3121.00 (54) pm, b = 335.07 (7) pm, and c = 959.18 (19) pm. Its structure is similar to that of niobium-rich sulfides, rather than to that of tantalum-rich sulfides. The metal coordinations are capped distorted cubic prisms and the coordinations of sulfur are capped trigonal prisms.

51217 **X-ray absorption studies of $YBa_2Cu_3O_{6+x}$, $La_{2-x}Sr_xCuO_4$, and $Nd_{2-x}Ce_xCuO_4$.** Lin, C.L. (Brookhaven National Laboratory Physics Department, Upton, NY (USA)); Qui, S.L.; Chen, J.; Strongin, M.; Crow, J.E.; Chu, C.W. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 199(1): 53-60 (25 Jan 1990). DOE Contract AC02-76CH00016. (CONF-891092–: 3. annual topical conference on high $T_c$superconducting thin films: processing, characterization, and applications, Boston, MA (USA), 23-27 Oct 1989).

O K-edge absorption studies show that the density of O 2p empty states near the Fermi level increases with increasing oxygen content for $YBa_2Cu_3O_{6+x}$, and Sr concentration in $La_{2-x}Sr_xCuO_4$. With Zn substitution for Cu in $YBa_2Cu_3O_7$, T_c does not correlate with the density of O 2p empty states. In this case T_c dramatically decreases with Zn substitution while the pre-edge feature remains

unchanged. The O K-edge spectrum of $Nd_{2-x}Ce_xCuO_4$ barely changes from the undoped, insulating, to the Ce doped superconducting sample. The lack of unoccupied O 2p states near the Fermi level in this case is consistent with naive expectations for electron-doping.

51218 Studies on ion scattering and sputtering processes in ion beam sputter-deposition of high $T_c$superconducting films: The optimization of deposition parameters. Ameen, M.S. (N. C. State University, Department of Materials Science and Engineering, Raleigh, NC 27695-7907 (USA)); Auciello, O.; Kingon, A.I.; Krauss, A.R.; Ray, M.A. *AIP Conference Proceedings (American Institute of Physics) (USA),* 199(1): 79-86 (25 Jan 1990). DOE Contract W-31109-ENG-38 ;FG05-88ER45359. (CONF-891092–: 3. annual topical conference on high $T_c$superconducting thin films: processing, characterization, and applications, Boston, MA (USA), 23-27 Oct 1989).

Ion beam sputter-deposition is one of the techniques used for synthesizing high T_c superconducting films in laboratory experiments. However, the scaling-up of this method for technological applications, such as in microelectronics, will require a better understanding of basic phenomena occurring during the deposition process. First results are presented here from experimental and computer simulation studies on ion scattering and sputtering processes. It is demonstrated that scattering of neutralized ions from the targets can result in undesirable erosion of, and inert gas incorporation in, the growing films, depending on the ion/target atom mass ratio and ion beam angle of incidence/target/substrate geometry. The studies indicate that sputtering by Kr^+ or Xe^+ ions is preferable to the most commonly used Ar^+ ions, since the undesirable phenomena mentioned above are minimized for the first two ions. These results are used to determine optimum sputter deposition geometry and ions beam parameters for growing high T_c films.

51219 Sputtered superconducting films of $Bi_2Sr_2CaCu_2O_x$ made by low-temperature, *in situ* growth. Kampwirth, R.T. (Materials Science Division, Argonne National Laboratory, Argonne, IL (USA)); Gray, K.E.; Andersen, P.H.; McDonald, D.B.; Miller, D.J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 199(1): 63-70 (25 Jan 1990). DOE Contract W-31109-ENG-38. (CONF-891092–: 3. annual topical conference on high $T_c$superconducting thin films: processing, characterization, and applications, Boston, MA (USA), 23-27 Oct 1989).

Composite target rf magnetron sputtering has previously been successfully employed to make superconducting films of $YBa_2Cu_3O_{7-x}$ *in-situ* at substrate temperature $T_s<700$ °C. We report the successful growth of superconducting films of $Bi_2Sr_2CaCu_2O_x$ on single crystal MgO substrates by a low-temperature process using dc magnetron sputtering from a Bi-enriched composite target. Using a substrate temperature $T_s\approx645$ °C, metallic films with a superconducting onset of 90–100 K and an extrapolated T_{c0}=56 K have been obtained. X-ray diffraction shows the films to be c-axis oriented. Electron microscopy reveals that the films are not significantly smoother nonsuperconducting phases had occurred. The exact mechanism by which crystallization and superconductivity occurs at such low temperatures is not yet known, but it can be speculated that the surface atoms are less constrained and thus have a smaller energy barrier to overcome in forming a crystal structure.

51220 The new superconductors: Prospects for applications. Wolsky, A.M. (Argonne National Laboratory, IL (USA)); Giese, R.F.; Daniels, E.J. *Scientific American (USA),* 260(2): 61-69 (Feb 1989).

Two years ago several groups around the world, excited by the discovery by K. Alex Mueller and J. Georg Bednorz of the IBM Zurich Research Laboratory of a superconducting ceramic oxide, developed an yttrium-barium-copper oxide that superconducted at 90 K. Since then other investigators have found two separate families of copper oxides, one incorporating bismuth and the other thallium, that superconduct at between 110 and 120 K. These high-temperature superconductors could be cooled to 77 degrees K with liquid nitrogen, which is cheap and abundant. This immediately suggested that certain applications of superconductivity long considered not to be economic or practical might be feasible. Yet many of the envisioned applications-generators and motors, energy storage, magnetically levitating trains-raise the same issues to which Onnes referred. It is not yet known whether the new materials can be made easily workable-strong and flexible enough to fashion into wire and other useful forms. Nor is it known whether they can be made to carry large currents and operate in intense magnetic fields. Whether the new discoveries will prove fruitful will depend on the progress made toward achieving design requirements for known applications and on identifying new applications as yet unforeseen. Indeed, such new applications may well have the greater impact. No one foresaw today's most important commercial use of superconductivity, magnetic-resonance imaging for medical diagnosis, in the 1960's, when niobium-3-tin and niobium-titanium were found to remain superconducting while carrying high currents in the presence of sizable magnetic fields. Leaving aside the unforeseen, an informed view of the economic and technical advantages of the new superconductors can help guide attempts to achieve the applications now being envisioned.

51221 Phenomenological model of nuclear relaxation in the normal state of $YBa_2Cu_3O_7$. Millis, A.J. (AT&T Bell Laboratories, 600 Mountain Avenue, Murray Hill, NJ (USA)); Monien, H.; Pines, D. *Physical Review, B: Condensed Matter (USA),* 42(1): 167-178 (1 Jul 1990).

A phenomenological model of a system of antiferromagnetically correlated spins is shown to give a good quantitative description of NMR, nuclear-quadrupole-resonance, and Knight-shift measurements on yttrium, planar copper, and planar oxygen sites in $YBa_2Cu_3O_7$. The antiferromagnetic correlation length is estimated to be ~2.5 lattice constants at T=100 K. The temperature dependence of the correlation length ceases at $T_x\cong100$ K. The enhancement of the observed relaxation rates over what is expected for weakly interacting electrons is calculated and shown to be large. Extension of the calculation to other cuprate superconductors is discussed.

51222 On the possible electronic instability of the monophosphate tungsten bronze $(WO_3)_4(PO_2)_4$. Canadell, E. (Universite de Paris-Sud, Orsay (France)); Whangbo, Myunghwan. *Journal of Solid State Chemistry (USA),* 86(1): 131-134 (May 1990).

The electronic structure of the monophosphate tungsten bronze $(WO_3)_4(PO_2)_4$ was examined by performing tight-binding band calculations. Our study suggests that the W_2O_{10} chains of $(WO_3)_4(PO_2)_4$ have both localized and delocalized electrons, and the latter may cause an electronic instability such as a charge density wave.

51223 The effects of secondary particle bombardment on ion beam sputtered thin films of $Y_1Ba_2Cu_3O_x$ deposited on MgO (100). Doyle, J.P. (IBM Research Division, T.J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY (USA)); Roy, R.A.; Cuomo, J.J.; Whitehair, S.J.; Mahoney, L.; McGuire, T.R.; Chisholm, M.F. *AIP Conference Proceedings (American Institute of Physics) (USA),* 199(1): 102-108 (25 Jan 1990). (CONF-891092–: 3. annual topical conference on high $T_c$superconducting thin films: processing, characterization, and applications, Boston, MA (USA), 23-27 Oct 1989).

We have investigated the effects of low energy bombardment on the microstructural, compositional, and electrical characteristics of ion beam sputtered thin films of $Y_1Ba_2Cu_3O_x$. During deposition, secondary bombardment of the growing film was performed using a Kaufman or ECR type ion source with energy ranging up to 125 eV. Microstructural changes have been characterized by TEM and XRD. Ion channeling has been performed to characterize the degree of orientation of the films. The effects of bombardment on the composition of the films were studied by RBS. It has been found that the use of an ECR microwave oxygen ion source trained on the growing films induces as-deposited superconductivity and also play a role in the texturing of the films. The effects of ion bombardment on the critical current (J_c) and temperature (T_c) are also reported.

51224 X-ray-absorption fine-structure studies of superconducting $Tl_2CaBa_2Cu_2O_x$ thin films. DiMarzio, D. (Department of Applied Science, Brookhaven National Laboratory, Upton, NY (USA)); Wiesmann, H.; Chen, D.H.; Heald, S.M. *Physical Review,*

B: Condensed Matter (USA), 42(1): 294-300 (1 Jul 1990). DOE Contract AC02-76CH00016.

Superconducting Tl-Ca-Ba-Cu-O thin films have been prepared by the technique of reactive magnetron sputtering using targets of Tl, Ca-Ba, and Cu. Three films with different quality superconducting transitions were fabricated and analyzed. X-ray-absorption fine-structure measurements were performed on the Cu *K* edge in order to determine orientation, bond lengths, number of nearest neighbors, and relative disorder as a function of the quality of their superconducting transition. Magnetically oriented powder samples of the appropriate superconducting phase were used for comparison. X-ray-absorption near-edge results reveal increasing CuO_2 plane orientation parallel to the substrate as the quality of the superconducting transition improved, consistent with x-ray-diffraction data. Extended x-ray-absorption fine-structure (EXAFS) measurements also show this trend. EXAFS gives a Cu-O(1) bond length of 1.92±0.01 A for all three films, and all three samples exhibit an increasing Debye-Waller disorder factor consistent with the deterioration in the quality of their superconducting transitions.

51225 High-resolution angle-resolved photoemission study of the Fermi surface and the normal-state electronic structure of $Bi_2Sr_2CaCu_2O_8$. Olson, C.G. (Ames Laboratory, Ames, IA (USA)); Liu, R.; Lynch, D.W.; List, R.S.; Arko, A.J.; Veal, B.W.; Chang, Y.C.; Jiang, P.Z.; Paulikas, A.P. *Physical Review, B: Condensed Matter (USA),* 42(1): 381-386 (1 Jul 1990). DOE Contract W-7405-ENG-82.

High-resolution angle-resolved photoelectron spectroscopic measurements were made of the Fermi edge of a single crystal of $Bi_2Sr_2CaCu_2O_8$ at 90 K along several directions in the Brillouin zone. The resultant Fermi-level crossings are consistent with local-density band calculations, including a point calculated to be of Bi-O character. Additional measurements were made where bands crossed the Fermi level between 100 and 250 K, along with measurements on an adjacent Pt foil. The Fermi edges of both materials agree to within the noise. Below the Fermi level the spectra show correlation effects in the form of an increased effective mass, but the essence of the single-particle band structure is retained. The shape of the spectra can be explained by a lifetime-broadened photohole and secondary electrons. The effective inverse photohole lifetime is linear in energy.

51226 Hall effect and electronic structure of $La_{2-x}Sr_xCuO_4$. Ruvalds, J. (Physics Department, University of Virginia, Charlottesville, VA (USA)); Virosztek, A. *Physical Review, B: Condensed Matter (USA),* 42(1): 399-405 (1 Jul 1990).

The unusual Hall coefficient R_H observed in $La_{2-x}Sr_xCuO_4$ single crystals is explained in terms of strong electron-electron scattering in a nearly half-filled Cu $d_{x^2-y^2}$ band E_l, together with a small number of holes in another band. Including multiple-scattering terms beyond the Born approximation yields an electron mobility that decreases dramatically as the Sr content is lowered toward $x \gtrsim 0.06$. There, a metal-insulator transition is predicted by our analysis for an on-site Coulomb coupling U of intermediate strength. Hence the minority-hole carriers yield a net positive R_H for $x<0.4$ by virtue of their higher mobility. Surprisingly, despite changes in R_H by orders of magnitude, the calculated plasma frequency remains nearly constant with $\omega_p \gtrsim 0.8$ eV over the metallic x range, in agreement with reflectivity data.

51227 Magnetic anisotropy of high-T_c superconductors. Tuominen, M. (Center for the Science and Application of Superconductivity, University of Minnesota, Minneapolis, MN (USA)); Goldman, A.M.; Chang, Y.Z.; Jiang, P.Z. *Physical Review, B: Condensed Matter (USA),* 42(1): 412-419 (1 Jul 1990). DOE Contract W-31109-ENG-38.

The magnetic anisotropies of $Bi_2Sr_2CaCu_2O_y$ and $YBa_2Cu_3O_{7-x}$ single crystals have been investigated by simultaneously measuring the longitudinal (M_L) and transverse (M_T) components of the equilibrium magnetization of crystals oriented at arbitrary angles with respect to the applied field direction. The variations of M_L and M_T as a function of orientation, field, and temperature have been measured. In the regime where the simple three-dimensional anisotropic London theory is valid, it is shown that the measurement of M_T/M_L with an applied field in the range $H_{c1} \ll H \ll H_{c2}$ yields the anisotropic mass ratio (m_3/m_1) directly. The possible breakdown of the simple theory is discussed.

51228 Anisotropic transport and cation disorder in superconducting $Tl_2Ca_2Ba_2Cu_3O_x$ single crystals. Tigges, C.P. (Sandia National Laboratories, Org. 1144, Albuquerque, New Mexico 87185 (USA)); Venturini, E.L.; Kwak, J.F.; Morosin, B.; Baughman, R.J.; Ginley, D.S. *Applied Physics Letters (USA),* 57(5): 517-519 (30 Jul 1990). DOE Contract AC04-76DP00789.

We have measured for the first time the temperature-dependent anisotropic resistivity of several $Tl_2Ca_2Ba_2Cu_3O_x$ single crystals. The resistivity ratio between the *c* axis and the *a-b* plane orientations in the best crystals is approximately 60 at room temperature. Resistivity data indicate substantial differences in both T_c and the transition width of nominal $Tl_2Ca_2Ba_2Cu_3O_x$ plates grown from two different melt compositions. A Tl-O and CuO-rich flux yielded approximately stoichiometric plates with sharp transitions beginning near 113 K, while a Tl-O-rich flux produced plates containing more Tl and less Ba with broad transitions starting near 103 K. These data demonstrate the extreme sensitivity of the superconductivity to cation site disorder in the Tl-Ca-Ba-Cu-O system.

51229 Large critical current densities in $YBa_2Cu_3O_{7-x}$ thin films made at high deposition rates. Wu, X.D. (Los Alamos National Laboratory, Los Alamos, NM (USA)); Muenchausen, R.E.; Foltyn, S.; Estler, R.C.; Dye, R.C.; Garcia, A.R.; Nogar, N.S.; England, P.; Ramesh, R.; Hwang, D.M.; Ravi, T.S.; Chang, C.C.; Venkatesan, T.; Xi, X.X.; Li, Q.; Inam, A. *Applied Physics Letters (USA),* 57(5): 523-525 (30 Jul 1990).

Critical current densities (J_c) in $YBa_2Cu_3O_{7-x}$ films made at deposition rates from 0.1 to 14.5 nm/s (~50 μm/h) were measured using a direct transport method. As the deposition rate was increased by two orders of magnitude, the films exhibited no marked degradation in current carrying capability with J_c of $\sim 4 \times 10^6$ A/cm^2 at 77 K and zero field. J_c for all the films showed similar behavior under a magnetic field up to 8 T, although extra structural defects were found in the films deposited at the higher rates. The results from this experiment indicate the feasibility for coating wires, tapes, and other macroscopic shapes with high T_c superconductors using proper vapor deposition techniques.

51230 Explanation of normal-state properties of high-temperature superconductors. Trugman, S.A. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM (USA)). *Physical Review Letters (USA),* 65(4): 500-503 (23 Jul 1990).

The magnetic susceptibility, Hall effect, thermopower, specific heat, and plasma frequency are calculated as a function of doping and temperature for $La_{2-x}Sr_xCuO_4$ and related compounds. There is good quantitative agreement with experiment. The calculation is based on quasiparticles in a Mott insulator, whose dispersion $\epsilon(\mathbf{k})$ is calculated variationally in the *t-t'-J* model (and the *t-J* model). The quasiparticles are assumed to form a weakly interacting Fermi liquid, which is treated in the relaxation-time approximation.

51231 Onset of valence and magnetic instabilities in the ferromagnetic semiconductor EuO at high pressures. Abd-Elmeguid, M.M. (Physics Division, MS K764, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Taylor, R.D. *Physical Review, B: Condensed Matter (USA),* 42(1): 1048-1051 (1 Jul 1990).

Hydrostatic high-pressure ^{151}Eu Moessbauer measurements ($0 \lesssim p \lesssim 31$ GPa) on the ferromagnetic semiconductor EuO reveal, contrary to previous suggestions, no pronounced valence change of Eu ($Eu^{2+} \rightarrow Eu^{3+}$) even at highest pressures (p=31 GPa). The magnetic ground state becomes unstable above 23 GPa, where the pressure-induced variation of the Curie temperature is consistent with theoretical predictions based on the volume-dependent competition between *sf*-exchange interactions and *sf* hybridization.

51232 Raman microprobe study of nanophase TiO_2 and oxidation-induced spectral changes. Parker, J.C. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Siegel, R.W. *Journal of Materials Research (USA),* 5(6): 1246-1252 (Jun 1990).

A Raman microprobe study of as-compacted nanophase TiO_2 was carried out to investigate the spatial inhomogeneity of its

anatase and rutile phases. Also, changes in the observed Raman spectra (line shifts and broadening) were investigated as a function of annealing at temperatures up to 600 °C in argon or air. Microscopic phase inhomogeneity is observed and Raman spectral changes are shown to result from inhomogeneous oxygen deficiency in the nanophase TiO_2. The line positions corresponding to the Raman active E_g modes in both anatase and rutile are found to be sensitive to this oxygen deficiency and are potential quantitative indicators of such deviations from stoichiometry.

3606 Other Materials

Refer also to citation(s) 50562, 50563, 50570, 50576, 50577, 50578, 50579, 50580, 50581, 50582, 50583, 50584, 50585, 50586, 50588, 50589, 50590, 50717, 50718, 50720, 50871, 51096, 51117, 51118, 51126, 51130, 51132, 51138, 51182, 51198, 51315, 51334, 51389, 51398, 51581, 51604, 51961, 51973, 52290, 52292, 52293, 52298, 52300, 52351, 52433

51233 (AD-A–223339/3/XAB) **Scanning tunneling microscopy of semiconductor surfaces. Final report, 1 April 1987-30 September 1989.** Quate, C.F.; Nogami, J. Stanford Univ., CA (USA). Edward L. Ginzton Lab. May 1990. 12p. Contract N00014-87-K-0679. (GL–4694). Source: NTIS, PC A03/MF A01.

This is a summary of results from a program aimed at studying the atomic structure of semiconductor surfaces using scanning tunneling microscopy (STM). The bulk of the research concerned the epitaxial growth of metals on the (111) and the (100) surfaces of silicon, with particular emphasis on the metals indium and gallium. The STM images provided structural information on all of the metal-induced surface reconstructions in these systems as well as information on the general behavior of the metals on the Si surface, yielding insight into metal mobility, the effect of stepped substrates, and the nucleation of metal growth on the surface. In addition to the semiconductor surface work, there has been some studies of the epitaxial growth of metals on Au(111), and the surface structure of the high temperature superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$.

51234 (AD-A–223801/2/XAB) **Development of dual-fiber-reinforced glass-matrix composites for structural space-based applications. Final report, 14 March 1988-14 March 1990.** Treadway, W.K.; Prewo, K.M. United Aircraft Corp., East Hartford, CT (USA). 31 May 1990. 50p. Contract N00014-88-C-0251. (UTRC-R–90-917886-1). Source: NTIS, PC A03/MF A01.

The goal of the program was to create high specific stiffness, zero thermal composites for structural applications in space by using dual fiber reinforcement approach. This approach consisted of adding large-diameter monofilaments as a secondary reinforcement to a pitch-based carbon fiber reinforces glass matrix composite. It was demonstrated that composite thermal expansion could be increased into the near-zero domain over the temperature range of interest (-100 C to +70 C) using a wide variety of monofilaments with and without fiber coatings. The use of uncoated boron monofilaments resulted in rather poor tensile performance and brittle fracture behavior due to degradation of the boron monofilaments during composite processing. The use of coated monofilaments resulted in a marked improvement in tensile strength and fracture behavior.

51235 (BNL–44922) **Development of thermally stable polymer concrete.** Megahed, T.N.E.D., Kukacka, L.E.; Fontana, J.J. Brookhaven National Lab., Upton, NY (USA). Oct 1989. 33p. Sponsored by U.S. DOE Energy Research; US Agency for International Development. DOE Contract AC02-76CH00016. Order Number DE91000127. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This work pertains to the development of a polymer concrete type that is thermally stable under working temperatures of 200° to 300°F. This material is highly durable and thermally stable with high flexural strength and ductility. Its consistency, while fresh, is suitable for both casting in place or precasting techniques. Several optimization stages were applied ranging from mixing ratios and type of aggregate to resin formulation itself. An optimized range of mixing ratios is developed along with optimized mix ingredients, relating mechanical performance to elevated temperature at various degrees of workability.

51236 (CONF-900528–3) **Structure-property relationships for β- and κ-phase BEDT-TTF salts and their use in the synthesis of κ-$(BEDT\text{-}TTF)_2Cu[N(CN)_2]Br$: A salt having the highest-Tsub c (inductive onset = 11.6K, resistive onset = 12.5K) yet observed in an organic superconductor.** Williams, J.M. (Argonne National Lab., IL (USA)); Kini, A.M.; Geiser, U.; Wang, Hau H.; Carlson, K.D.; Kwok, W.K.; Vandervoort, K.G.; Thompson, J.E.; Stupka, D.L.; Jung, D.; Whangbo, M.H. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International conference on organic superconductors; Lake Tahoe, CA (USA); 20-24 May 1990. Order Number DE90017804. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new ambient pressure organic superconductor, κ-$(ET)_2Cu[N(CN)_2]Br$, has been discovered with an inductive onset T_c= 11.6 ± 0.1 K (resistive onset = 12.5 ± 0.1 K). The anion in the new salt consists of a polymeric mixed (halide)(pseudohalide)cuprate(I) species. Because of the large number of metal/halide/pseudohalide substitutions that can be made in this anionic species, it opens up an entirely new conceptual approach to the design of additional conducting and superconducting (with even higher T_c's) cation-radical salts by use of planar polymeric anions. Studies along these lines are currently under way in our laboratory. It is also becoming increasingly clear that in terms of structure (both are layered superconductors) and the physics (both are type II-superconductors with anisotropic coherence lengths, anisotropic H_{c2}, and in which superconductivity is competing with magnetic ground states, etc.),the organic superconductors are more similar to the high-$T_c$oxide superconductors than to other classes of superconductors. Thus, the prospects for discovering high-$T_c$in organic systems appear very bright!

51237 (CONF-9006273–1) **Bragg intensities and diffuse scattering in Ag_2Se: A molecular dynamics study.** Rino, J.P. (Sao Carlos Univ., SP (Brazil)); Vashishta, P.; Kalia, R.K. Argonne National Lab., IL (USA). Aug 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 14. workshop on condensed matter theories; Elba (Italy); 18-23 Jun 1990. Order Number DE90017811. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Superionic conductor Ag_2Se is studied with the molecular dynamics technique using effective two-body interaction pair potentials. These interaction potentials include steric, charge transfer, and charge-dipole interactions. The superionic phase is characterized by a stable bcc sublattice of Se^{--} ions in which Ag^+ ions exhibit liquid-like diffusion. The temperature dependence of the structural and dynamical correlations are studied. The results for structural correlations include the pair distribution functions, coordination numbers, bond angle distributions, and wave vector dependence of the Bragg intensities. A detailed comparison with neutron and x-ray scattering results is made wherever possible. The anomalous diffuse neutron and x-ray scattering in the vicinity of q_0=(1.6,1,0) is calculated. 25 refs., 8 figs.

51238 (DOE/ER/30152–H1T) **Polymer matrix composites research: A survey of federally sponsored programs: Final report.** Walcoff and Associates, Inc., Alexandria, VA (USA). Jun 1990. 168p. Sponsored by U.S. DOE Energy Research. DOE Contract AC01-89ER30152. Order Number DE91000453. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report identifies research conducted by agencies of the federal government other than the Department of Energy (DOE) in the area of advanced polymer matrix composites (PMCs). DOE commissioned the report to avoid duplicating other agencies' efforts in planning its own research program for PMCs. PMC materials consist of high-strength, short or continuous fibers fused together by an organic matrix. Compared to traditional structural metals, PMCs provide greater strength and stiffness, reduced weight and increased heat resistance. The key contributors to PMC research identified by the survey are the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Department of Transportation (DOT). The survey identified a total of 778 projects. More than half of the total projects identified emphasize materials research with a goal toward developing materials with improved

performance. Although an almost equal number of identified materials projects focus on thermosets and thermoplastics receive more attention because of their increased impact resistance and their easy formability and re-formability. Slightly more than one third of projects identified target structures research. Only 15 percent of the projects identified focus on manufacturing techniques, despite the need for efficient, economical methods manufacturing products constructed of PMCs–techniques required for PMCs to gain widespread acceptance. Three issues to be addressed concerning PMCs research are economy of use, improvements in processing, and education and training. Five target technologies have been identified that could benefit greatly from increased use of PMCs: aircraft fuselages, automobile frames, high-speed machinery, electronic packaging, and construction.

51239 (IS-T–1445) **Electrical resistivity of some Zintl phase and the precursors.** Wolfe, L. Ames Lab., IA (USA). 21 Sep 1990. 59p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000742. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Resistivity measurements have been performed for electric characterization of the compounds Ba_5Sb_3 and Ba_5Sb_3Cl, both with the Mn_5Si_3 structure type, along with Ca_5Bi_3 and Ca_5Bi_3F, both with the β-Yb_5Sb_3 structure type. These measurements were taken as a function of temperature using the four probe method on pressed polycrystalline pellets of the compounds. A sealed apparatus was developed for containing these air-sensitive compounds throughout the experiments. By a simple electron count, one extra electron in both Ba_5Sb_3 and Ca_5Bi_3 should occupy a conduction band, giving these compounds a metallic character. In the cases of Ba_5Sb_3Cl and Ca_5Bi_3F, the extra electron should bond to the halide, both filling the valence band and giving rise to semiconducting character. Ca_5Bi_3, Ca_5Bi_3F, and Ba_5Sb_3Cl were found to comply with the electron count prediction. Ba_5Sb_3, however, was found to be a semiconductor (E_g = 0.30 eV) with a larger band gap than its corresponding chloride (E_g = 0.09 eV).

51240 (IS-T–1457) **Bond and low cycle fatigue behavior of thermoset composite reinforcing for the concrete industry.** Barnes, B. Ames Lab., IA (USA). 21 Sep 1990. 168p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000201. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This thesis encompasses two separate research projects. The first project, described in Chapter 2 was a project investigating the fatigue behavior of thermoset Fiber Composite (FC) sandwich wall ties. The second research project detailed in this thesis was a project studying the bond and tensile properties of FC rod and FC fibers.

51241 (Juel–2353) **Investigation of the sorption of cesium by graphitic reactor materials.** Kwasny, J.; Hilpert, K.; Nickel, H. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorwerkstoffe; Technische Hochschule Aachen (Germany, F.R.). Apr 1990. 166p. (In German). Order Number DE91712480. Source: NTIS (US Sales Only), PC A08/MF A01.

Dissertation submitted by J. Kwasny.

A Knudsen cell-mass spectrometer system has been developed for vapour pressure measurements to determine the sorption isotherms of Cs for graphitic reactor materials. Double Knudsen cells heated by high frequency were employed in this system. A high vacuum furnace with a specially designed oven-cell was used for isopiestic experiments carried out in addition to the mass spectrometric studies. The Cs equilibrium partial pressure was measured at temperatures 950 and 1820 K over A3-3 fuel element matrix with Cs concentrations between 0.17 and 34.76 mmol/kg. Sorptionisotherms of Cs according to Henry and Freundlich were evaluated from the vapour pressure data. The sorption enthalpies for Cs obtained indicate a strong bond by chemisorption. The Cs sorption of the 'reactor graphites' A3-3, A3-27, ASR-1RG, ASR-1RS, ASR-2RS, PAN, P3-JHAN, PXA-2N, H-451, H-327, IG-110 and the coat-mix materials CM-100 and CM-30 resulted by the isopiestic method. It could be shown that graphitic reactor materials with phenolic resin binder are able to bind a substantially higher amount of Cs by sorption than 'reactor graphites' without this binder. (orig./MM).

51242 (LA-UR–90-3170) **Thermodynamics and magnetism in $Th_xU_{1-x}Be_{13-y}B_y$.** Heffner, R.H. (Los Alamos National Lab., NM (USA)); Beyermann, W.P.; Hundley, M.F.; Thompson, J.D.; Smith, J.L.; Fisk, Z.; Bedell, K.; Birrer, P.; Baines, C.; Gygax, F.N.; Hitti, B.; Lippelt, E.; Ott, H.R.; Schenck, A.; MacLaughlin, D.E. Los Alamos National Lab., NM (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-901004–6: Conference on magnetism and magnetic materials, San Diego, CA (USA), 30 Oct - 2 nov 1990). Order Number DE91000372. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report specific heat and μSR measurements on Th (x = 0.019) and/or B (y = 0.03) substituted UBe_{13}. The specific heat data show that either Th or B substitution reduces the Kondo temperature T_K and increases the entropy at the superconducting transition by almost 20%, indicating an enhanced density of states. However, whereas μSR shows clear evidence for magnetic correlations for Th substitutions ($0.019 < x < 0.043$), no magnetism is observed for B substitutions. The enhanced specific heat jump in the B-substituted material is associated with a change in the superconducting properties as T_K is reduced.

51243 (LBL–26455, pp. 55-56) **Variational spectroscopy of a silane monolayer at air/solid and liquid/solid interfaces using sum-frequency generation.** Guyot-Sionnest, P.; Superfine, R.; Hunt, J.H.; Shen, J.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The understanding of liquid/solid interfaces is of central importance in surface science and technology. For decades, they have been studied by methods such as contact-angle measurements, capacitance measurements, and liquid chromatography, yielding mostly information on the macroscopic level. Techniques so successful at probing vacuum/solid interfaces are generally inapplicable here. The recently developed optical SHG technique does allow one to probe various types of interfaces, including liquid/solid and liquid/liquid, but it is incapable of a selective study of adsorbed molecules via their vibrational spectroscopy. As a remedy, their group recently extended SHG to infrared-visible sum-frequency generation (SFG) for surface vibrational spectroscopic studies. The authors report here the first application of SFG to a liquid/solid interface. Although infrared techniques have been applied to probe the liquid/solid interface, SFG, being intrinsically surface sensitive, will allow the study of a much wider range of geometries and substrates. The system they chose to study is OTS adsorbed at the interfaces between fused silica and different solvents. They present the first application of infrared-visible SFG to studies of liquid/solid interfaces.

51244 (LBL–26455, pp. 65) **Optical characterization of epitaxial GaAs films grown on Si.** Huang, Y.; Yu, P.Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Epitaxial GaAs films grown on Si are one of the most extensively studied heteroepitaxial systems. From the technological point of view, the system promises to combine the desirable optoelectronic properties of GaAs for optical communication with the well-established Si technology. From the materials science point of view, it poses interesting challenges because of the differences in the lattice constants ionicities between GaAs and Si. although the quality of GaAs film grown on Si is still far inferior to GaAs films grown on GaAs substrates, methods of growing high-quality epitaxial GaAs films on Si are continuously being proposed. Optical techniques such as photoluminescence and light scattering have been shown to be fast, nondestructive, and sensitive in characterizing these thin-film samples. In collaboration with Prof. S. Wang's group, defects in epitaxial GaAs films grown on Si by molecular-beam epitaxy (MBE) have been studied optically. One proposed method of reducing stress and defects in this heteroepitaxial system is to use selective-area MBE growth in which crystalline GaAs is surrounded by polycrystalline GaAs. Using photoluminescence at 77 K, the thermal stress and crystal quality of narrow strips of GaAs (width varying between 4 and 100 μm) fabricated by both selective-area MBE and chemical etching have been studied.

51245 (LBL–26455, pp. 65) **Effect of pressure on the DX centers in GaAs and related GaAlAs semiconductor alloys.** Li, M.; Shan, W.; Yu, P.Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Recently there has been much interest in the properties of a deep center known as the DX center found in GaAs and GaAlAs alloys. The pressure dependence of the activation energies for both capture and emission in these centers has been measured. The results are consistent with the large-lattice relaxation model for the structure of these centers. The behavior of these centers with a direct band gap was compared with the behavior of centers with an indirect band gap. When the band gap is direct, carriers are captured into the DX centers through the L valleys, while carriers are captured through the X valleys when the band gap is indirect.

51246 (LBL–26455, pp. 66) **Reduction of persistent photoconductivity due to DX centers in GaAs by boron.** Li, M.; Shan, W.; Yu, P.Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Persistent photoconductivity in n-type GaAlAs and in GaAs under pressure has been attributed to deep centers known as DX centers. In studying these centers in GaAs contaminated by boron during liquid-encapsulated Czochralski growth, it was discovered that boron could reduce persistent photoconductivity in the DX center by decreasing its capture barrier height. This effect of boron was confirmed by implanting B into GaAs that did not contain B. An explanation of this effect of B is still lacking. Boron is an isovalent impurity in GaAs and is known to be electrically inactive in GaAs or GaAlAs alloys. A plausible explanation is that isovalent impurities such as B may reduce the lattice relaxation surrounding the donor atoms and hence minimize the effect of persistent photoconductivity. This finding may have significant impact on GaAs technology in making high-electron-mobility transistor (HEMT) devices practical.

51247 (LBL–26455, pp. 66) **Pressure dependence of Schottky barrier at the Pt/GaAs interface.** Shan, W.; Li, M.; Yu, P.Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

It has been proposed that the pinning of the Fermi level in the middle of the band gap of GaAs and other III-V semiconductors results from intrinsic defects, such as EL2, or extrinsic defects created by the metal overlayers. This hypothesis has been tested by measuring the pressure dependence of the Schottky barrier height formed by Pt on GaAs and comparing the pressure coefficient with those of the known defects in GaAs. It was found that the Schottky barrier followed the valence band as a function of pressure. This result rules out defects such as EL2 as being responsible for the Schottky barrier. On the other hand, this result was consistent with other intrinsic defects, such as E3 and E4, as responsible for pinning the Fermi level.

51248 (LBL–26455, pp. 66) **Pressure dependence of defect centers at the (111) Si/SiO_2 interface.** Shan, W.; Yu, P.Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Defects at the Si/SiO_2 interface are very important for Si electronic devices and have been studied extensively. An amphoteric paramagnetic center, known as the P_b center, has been identified by electron-spin resonance and electrical measurements. Two models have been proposed to explain the origin of the P_b center. On model involves a threefold coordinated Si with a dangling bond, while the other model suggested a overcoordinated Si with a floating bond. Edwards predicted that the one-to-two-hole transition of the P_b center would shift toward the valence band for a dangling bond and toward the conduction band for the floating bond. In collaboration with Dr. Noble Johnson of Xerox Palo Alto Research Center, the pressure dependence of the one-to-two-hole transition of the P_b center has been determined using the diamond anvil cell and constant-capacitance DLTS. The transition was found to shift toward the valence band at a rate of about – 1.2 meV/kbar, in good quantitative agreement with the predictions of the dangling-bond model.

51249 (LBL–26455, pp. 68-69) **Flux noise in thin films.** Ferrari, M.J.; Johnson, M.; Clarke, J.; Rosenthal, P.A.; Hammond, R.H.; Beasley, M.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

One of the earliest applications of the high-T_c thin films is to SQUIDs. A SQUID consists of a superconducting loop interrupted by one or two Josephson junctions. The voltage produced by the SQUID is periodic in the applied magnetic flux. The device is an exceedingly sensitive detector of flux and has wide-ranging applications, from biomagnetism to geophysics. High-T_c SQUIDs made at IBM and elsewhere exhibit high levels of low-frequency noise, and the present project was designed to investigate the origin of this noise. In the experiment, a thin film of $YBa_2Cu_3O_7$ (YBCO), made at Stanford, was patterned into a 1-mm-square washer with a 200-μm-square hole in the middle. The film was mounted very close to a conventional Nb-based SQUID, the whole assembly being surrounded by a vacuum can. The SQUID was maintained at 4.2 K, while the temperature of the film could be raised to the transition temperature of the YBCO. Any flux noise generated in the film was measured by the SQUID. It was found that high levels of 1/f flux noise (where f is frequency) were generated by the YBCO films in the frequency range studied, 1-10^3 Hz. The magnitude of the noise increased with temperature.

51250 (LBL–26455, pp. 76) **Theoretical studies of the electronic properties of solid surfaces.** Falicov, L.M. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The purpose of this program is to study properties of solid surfaces. In particular, the interest is in determining (a) structural properties of surfaces, namely the organization and arrangement of atomic constituents at equilibrium; (b) constitutional properties of the surface, in particular the segregation properties of alloys at the surface as a function of crystal structure, surface orientation, nominal chemical composition, and temperature; (c) electronic structure of surfaces, in particular electron states and electron densities in the neighborhood of the surface; (d) vibronic properties of surfaces; (e) magnetic properties of surfaces, both in magnetic solids (ferromagnetic and antiferromagnetic) and in nonmagnetic solids that may develop a magnetic surface layer; and (f) chemical properties of solids - in particular their catalytic properties - as they are related to all the basic physical properties listed above. A variety of theoretical techniques and models have been developed to focus on the various properties (band-structure models, many-body electron physics, numerical relaxation techniques), but the emphasis is on physical aspects and their implication to experiments rather than on techniques per se. Since 1978 a collaboration has been established with Dr. Eugene Haller and his group to study a set of unusual impurities in very pure semiconductors. These impurities had never been seen before and include hydrogen complexes, lithium-based complexes, carbon-nitrogen complexes, and ordinary substitutional impurities in an unusual charge state.

51251 (LBL–26455, pp. 65) **Time-resolved spectroscopies in solids.** Yu, P.Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The purpose of this project is to use picosecond and subpicosecond laser pulses generated by modelocked dye lasers to study ultrafast interactions between elementary excitations in solids. An understanding of these interactions, such as between electrons and phonons and among electrons, is important in the design of new generations of fast electronic devices. Nonequilibrium phonons and electron-hole plasmas are excited in semiconductors such as GaAs by picosecond and subpicosecond laser pulses. Their subsequent expansion and cooling are monitored as a function of time by techniques such as photoluminescence and Raman scattering. The influence of defects, impurities, carrier confinement, and external perturbations such as strain are also investigated. The effects of pressure on the electrical and optical properties of solids are also studied using diamond

anvil high-pressure cells. The effect of pressure on defect levels in semiconductors and at semiconductor interfaces has been studied by capacitance techniques such as deep-level transient spectroscopy (DLTS) and photocapacitance techniques.

51252 (LBL–29258) **A study of the chemical, mechanical, and surface properties of thin films of hydrogenated amorphous carbon.** Vandentop, G.J. Lawrence Berkeley Lab., CA (USA). Jul 1990. 145p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE91000357. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Amorphous hydrogenated carbon (a-C:H) films were studied with the objective of elucidating the nucleation and growth mechanisms, and the origin of their unique physical properties. The films were deposited onto Si(100) substrates both on the powered (negatively self-biased) and on the grounded electrodes from methane in an rf plasma (13.56 MHz) at 65 mTorr and 300 to 370 K. The films produced at the powered electrode exhibited superior mechanical properties, such as high hardness. A mass spectrometer was used to identify neutral species and positive ions incident on the electrodes from the plasma, and also to measure ion energies. The effect of varying ion energy flux on the properties of a-C:H films was investigated using a novel pulsed biasing technique. It was demonstrated that ions were not the dominant deposition species as the total ion flux measured was insufficient to account for the observed deposition rate. The interface between thin films of a-C:H and silicon substrates was investigated using angle resolved x-ray photoelectron spectroscopy. A silicon carbide layer was detected at the interface of a hard a-C:H film formed at the powered electrode. At the grounded electrode, where the kinetic energy is low, no interfacial carbide layer was observed. Scanning tunneling microscopy and high energy electron energy loss spectroscopy was used to investigate the initial stages of growth of a-C:H films. On graphite substrates, films formed at the powered electrode were observed to nucleate in clusters approximately 50 Å in diameter, while at the grounded electrode no cluster formation was observed. 58 figs.

51253 (LBL–29305) **Magnetic and optical properties of Np and Pu ions and compounds.** Edelstein, N.M. Lawrence Berkeley Lab., CA (USA). Aug 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900846–3: International symposium to commemorate the 50th anniversary of discovery of transuranium elements, Washington, DC (USA), 26-31 Aug 1990). Order Number DE91000356. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three topics are reviewed in this paper. They are the magnetic and optical properties of NpF_6 and PuF_6, $Np(BH_3CH_3)_4$, and the hyperfine anomaly of $^{239,241}Pu$. Based on recent optical data of NpF_6 and PuF_6 in Ar matrices, new crystal field analyses of these molecules are presented. The temperature dependent ^1H and ^{11}B NMR shifts of $Np(BH_3CH_3)_4$ are discussed. 40 refs., 4 figs., 8 tabs.

51254 (NUREG/CR–5542) **Models for estimation of service life of concrete barriers in low-level radioactive waste disposal.** Walton, J.C. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Plansky, L.E.; Smith, R.W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; EG and G Idaho, Inc., Idaho Falls, ID (USA). Sep 1990. 38p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2597). Source: NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Concrete barriers will be used as intimate parts of systems for isolation of low level radioactive wastes subsequent to disposal. This work reviews mathematical models for estimating the degradation rate of concrete in typical service environments. The models considered cover sulfate attack, reinforcement corrosion, calcium hydroxide leaching, carbonation, freeze/thaw, and cracking. Additionally, fluid flow, mass transport, and geochemical properties of concrete are briefly reviewed. Example calculations included illustrate the types of predictions expected of the models. 79 refs., 24 figs., 6 tabs.

51255 (ORNL/FTR–3751) **[Chemically vapor deposited diamond films]: Foreign trip report, July 18–August 23, 1990.** Clausing, R.E.; Heatherly, L. Jr. Oak Ridge National Lab., TN (USA). 22 Sep 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000384. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The NATO-ASI on "Diamond and Diamond-Like Films and Coatings" was an opportunity for us to learn the latest research results from ongoing programs in the leading laboratories of the world and relate them to our work. Specific examples are given in the comprehensive report which follows. The meeting format provided an ideal environment to meet and interact with our international counterparts. It is clear that our studies are well regarded, and that we have established an excellent reputation in a short time. New opportunities for collaboration were identified. A panel discussion at the end of the meeting addressed the needs and opportunities in the synthesis of CVD diamond. The key scientific needs are those related to modeling the nucleation and growth processes and to elucidation of the critical roles of atomic hydrogen and the mechanisms of carbon addition to the growing surfaces. The development and more extensive use of in situ diagnostics for both surface and gas phases are important to solving these issues. The more immediate practical questions concern the identification of the growth-rate-limiting steps, the relation of growth parameters to the resulting film structure, and the dependence of properties on structure.

51256 (SAND–89-2656) **Attenuation studies of booster-rocket propellants and their simulants.** Weirick, L.J. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000098. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A series of impact experiments on a composite propellant, an energetic propellant, and their simulants was recently completed using a light-gas gun. Previous experiments were done to obtain Hugoniot data, to investigate the pressure threshold at which a reaction occurs, and to measure spall damage at various impact velocities. The present studies measured the attenuation of shock waves in these materials, completing the shock characterization needed for material modeling. An initial impulse of 2.0 GPa magnitude and ~0.6 μs duration was imposed upon samples of various thicknesses. VISAR was used to measure the free-surface velocity at the back of the samples; these data were used to generate a curve of shock-wave attenuation versus sample thickness for each material. Results showed that all four materials attenuated the shock wave very similarly. Material thicknesses of 3.0, 7.62, 12.7, and 19.0 mm attenuated the shock wave ~16%, 33%, 50%, and 66% respectively. 14 refs., 12 figs., 4 tabs.

51257 (SAND–90-2470C) **New k-phase materials, k-$(ET)_2Cu[N(CN)_2]X$: X = Cl, Br and I: The synthesis, structure and superconductivity above 11 K in the Cl (T_c= 12.8 K, 0.3 kbar) and Br(T_c= 11.6 K) salts.** Wang, H.H. (Argonne National Lab., IL (USA)); Carlson, K.D.; Geiser, U.; Kini, A.M.; Schultz, A.J.; Williams, J.M.; Montgomery, L.K.; Kwok, W.K.; Welp, U.; Vandervoort, K.G.; Boryschuk, S.J.; Strieby Crouch, A.V.; Kommers, J.M.; Watkins, D.M.; Schirber, J.Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789 ;FG05-86ER45259 ;W-31109-ENG-38. (CONF-9009257–1: International conference on science and technology of synthetic metals, Tuebingen (Germany, F.R.), 2-7 Sep 1990). Order Number DE91000029. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The syntheses, structures, selected physical properties, and band electronic structures of three copper (I) dicyanamide halide salts of bis(ethylenedithio)tetrathiafulvalene [κ-$(ET)_2Cu[N(CN)_2]X$, where X = Cl, Br, and I] are discussed. X-ray crystallographic studies demonstrate that the three derivatives are isostructural. The bromide salt is an ambient pressure superconductor with an inductive onset at 11.6 K and a resistive onset at 12.5 K. κ-$(ET)_2Cu[N(CN)_2]Cl$ exhibits the highest reported superconducting transition temperature (T_c= 12.8 K, 0.3 kbar) for an organic superconductor, once a semiconductor-semiconductor transition (42 K) is suppressed. The application of GE varnish or Apiezon N grease to crystals of κ-$(ET)_2Cu[N(CN)_2]Cl$ provides sufficient stress to induce superconductivity at "ambient pressure." Crystals of the iodide

remain metallic to ~150 K, where they become weakly semiconductive. No sign of superconductivity was detected at pressures (hydrostatic and shearing) up to 5.2 kbar and at temperatures as low as 1.1 K. The band electronic structures of the three salts are essentially identical. The differences in superconducting properties are explained in terms of differences in lattice softness, which are strongly influenced by short C-H···donor and C-H···anion contacts. 17 refs., 2 figs.

51258 (UCRL-CR–104934) **Photoconductivity of activated carbon fibers.** Kuriyama, K. (Massachusetts Inst. of Tech., Cambridge, MA (USA)); Dresselhaus, M.S. Lawrence Livermore National Lab., CA (USA). Aug 1990. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000814. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The photoconductivity is measured on a high-surface-area disordered carbon material, namely activated carbon fibers, to investigate their electronic properties. Measurements of decay time, recombination kinetics and temperature dependence of the photoconductivity generally reflect the electronic properties of a material. The material studied in this paper is a highly disordered carbon derived from a phenolic precursor, having a huge specific surface area of 1000–2000m^2/g. Our preliminary thermopower measurements suggest that this carbon material is a p-type semiconductor with an amorphous-like microstructure. The intrinsic electrical conductivity, on the order of 20S/cm at room temperature, increases with increasing temperature in the range 30–290K. In contrast with the intrinsic conductivity, the photoconductivity in vacuum decreases with increasing temperature. The recombination kinetics changes from a monomolecular process at room temperature to a biomolecular process at low temperatures. The observed decay time of the photoconductivity is ≃0.3sec. The magnitude of the photoconductive signal was reduced by a factor of ten when the sample was exposed to air. The intrinsic carrier density and the activation energy for conduction are estimated to be ≃10^{21}/cm^3 and ≃20meV, respectively. The majority of the induced photocarriers and of the intrinsic carriers are trapped, resulting in the long decay time of the photoconductivity and the positive temperature dependence of the conductivity. 54 refs., 11 figs., 3 tabs.

51259 (UCRL-JC–104279) **A comparison of mechanical properties and scaling law relationships for silica aerogels and their organic counterparts.** Pekala, R.W.; Hrubesh, L.W.; Tillotson, T.M.; Alviso, C.T.; Poco, J.F.; LeMay, J.D. Lawrence Livermore National Lab., CA (USA). Aug 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901105–13: Fall meeting of the Materials Research Society, Boston, MA (USA), 24 Nov - 1 dec 1990). Order Number DE91000282. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Aerogels are a special class of open-cell foams derived from the supercritical extraction of highly crosslinked, inorganic or organic gels. The resultant materials have ultrafine cell/pore sizes (< 100 nm), high surface areas (350–1000m^2/g), and a microstructure composed of interconnected colloidal-like particles or polymeric chains with characteristic diameters of 10 nm. TEM and SAXS show that this microstructure is sensitive to variations in processing conditions that influence crosslinking chemistry and growth processes prior to gelation. Traditional silica aerogels are prepared via the hydrolysis and condensation of tetramethoxy silane (TMOS) or tetraethoxy silane (TEOS). Factors such as pH and the [H_2O]/[TMOS] ratio affect the microstructure of the dried aerogel. It is generally accepted that 'polymeric' silica aerogels result from acid catalysis while 'colloidal'silica aerogels result from base catalysis. Recently, Hrubesh and Tillotson developed a new 'condensed silica' procedure for obtaining silica aerogels with densities as low as 0.004g/cc, i.e. only 3x the density of air. Organic aerogels are formed from the aqueous, polycondensation of (1) resorcinol/formaldehyde or (2) melamine/formaldehyde. The microstructure of the resorcinol-formaldehyde (RF) aerogels is dictated by the amount of base catalyst used in the sol-gel polymerization. In addition, these materials can be pyrolyzed in an inert atmosphere to form vitreous carbon aerogels. Melamine- formaldehyde (MF) aerogels that are both colorless and transparent are only formed under acidic conditions (i.e. pH = 1–2). In this paper, the microstructural dependence and scaling law relationships for the compressive modulus of silica, carbon, RF, and MF aerogels will be discussed in detail. 17 refs., 1 fig.

51260 (Y/TR–90/11) **Manufacture of lithium.** Sasagawa, Yukio (Nippon Soda Co. Ltd., Tokyo (Japan)); Yokoo, Junjiro; Higuchi, Haruo; Ito, Hideaki. Oak Ridge Y-12 Plant, TN (USA). 1990. 14p. Translation of Japanese Patent Application No. 1-152226, June 14, 1989. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. Order Number DE91000881. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This invention is a manufacturing method for lithium. A lithium manufacturing method was developed with the characteristics listed below. Mixed fused salts containing lithium chloride are electrolyzed to yield lithium and chlorine gas. Lithium carbonate and a chlorinating agent are added to a portion of the fused salts that is extracted from the electrolytic cell; lithium carbonate is chlorinated and lithium chloride is produced in the mixed fused salts. The mixed fused salts are returned to the electrolytic cell, and the lithium chloride that had been consumed during electrolysis is replenished. This report is a patent application for the lithium manufacturing method.

51261 **Scattering from gas-phase synthesized particles.** Hurd, A.J. (Sandia National Lab., Albuquerque, NM (US)). pp. 3-14 of Optical fiber materials and processing: Materials Research Society Symposium Proceedings. Volume 172. Fleming, J.W.; Sigel, G.H. Jr.; Takahashi, S.; France, P.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 357 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

Rational design and optimization for the next generation of fiber optics requires fundamental knowledge of the processes at each step of production, not the least of which is the formation and deposition of the glass precursor particles. Currently, gas-phase synthesis dominates the industry, owing, in part, to the high purity possible for gaseous reagents. However, the production, engineer has relatively little control over the microstructure of the boule from which the fiber is drawn because many complex mechanisms take part in the growth and thermophoretic deposition of the precursors. The goal of this paper is to review some of the aspects of scattering studies of gas-phase synthesized particles and to cite some of the pertinent findings for fumed silica.

51262 **Chemical reactions at glass/liquid interfaces.** Ferris, K.F. (Pacific Northwest Lab., Materials and Chemical Sciences Center, Richland, WA (US)); Sosa, C.P.; Pederson, L.R. pp. 65-70 of Optical fiber materials and processing: Materials Research Society Symposium Proceedings. Volume 172. Fleming, J.W.; Sigel, G.H. Jr.; Takahashi, S.; France, P.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 357 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper reports electronic structure calculations performed on model silicate complexes in the presence of a perturbing dielectric field. Solid state dielectric effects were represented by an electrostatic representation of surrounding molecular subunits, which were developed from quantum mechanical electron density distributions. Only minor changes in the molecular geometry of the surface silicate model were noted; however, significant intramolecular charge redistribution and intermolecular interaction energy changes occur in the presence of the perturbing field. Molecular probes of surface absorption show a differential stabilization of donor and acceptor interactions for hydrogen bonding species.

51263 **Infrared reflectance measurement of ion implanted silica.** Magruder, R.H. III (Belmont College, Nashville, TN (US)); Morgan, S.H.; Weeks, R.A.; Zuhr, R. pp. 10-19 of Properties and characteristics of optical glass. Marker, A.J. III. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). pp. 213 (CONF-8808214–: Properties and characteristics of optical glass, San Diego, CA (USA), 18-19 Aug 1988).

This paper discusses infrared reflectance spectra of silica glass implanted with Ti, Cr, Mn, Fe, and Bi to doses between 0.5–6 x 10^{16} cm^{-2} that have been measured from 5000 cm^{-1} to 400 cm^{-1} at room temperature. The ion energy of the implantation was 160 KeV and the current was 10μA. Alterations in reflectance of bands at 1125 and 481 cm^{-1} in the spectrum of an unimplanted

sample of the order of 20% are observed. A band attributed to non-bridging oxygen ions at ~1015 cm^{-1} is observed to increase in intensity with increasing dose for all species. The authors report that the band at 1125 cm^{-1} is observed to shift to lower wavenumber with implantation. Bands due to implanted ion-oxygen vibrations were not detected. The magnitudes of the effects on the existing bands were ion specific. This ion specificity is attributed to the differing chemical states of the implanted ions after implantation.

51264 Semiconductor particle mediated photoelectron transfers in bilayer lipid membranes. Fendler, J.H. (Syracuse Univ., NY (USA). Dept. of Chemistry); Baral, S. pp. 148-160 of Photochemical energy conversion. Norris, J.R.; Meisel, D. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). pp. 364 (CONF-880767--: 7. international conference on photochemical conversion and storage of solar energy, Evanston, IL (USA), 31 Jul - 5 aug 1988).

This paper discusses semiconductor particles *in situ* generated on the *cis* surface of glyceryl monooleate (GMO) bilayer lipid membranes (BLMs), that have been used to mediate photoelectric effects. The presence of semiconductors on the BLM surface is addressed. The observed photoelectric effects are rationalized and presented.

51265 Characterization of InP on Si grown by MBE. Lee, H.Y. (Dept. of Electrical Engineering and the Center for Optoelectronic Computing Systems, Colorado State Univ., Fort Collins, CO (US)); Crumbaker, T.E.; Hafich, M.J.; Robinson, G.Y.; Al-Jassim, M.M.; Jones, K.M. pp. 104-107 of Proceedings of the first international conference on indium phosphide and related materials for advanced electronic and optical devices: Volume 1144. Singh, R.; Messick, L.J. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 649 (CONF-8903157--: 1. international conference on indium phosphide and related materials for advanced electronic and optical devices, Norman, OK (USA), 20-22 Mar 1989).

This paper describes the characterization of large area InP single crystal films grown by gas-source MBE on (100) Si substrates. To accommodate the 8% InP-Si lattice mismatch, a strained-layer superlattice of InGaP was used as a buffer layer. The dislocation density in the InP, as determined by TEM, was 10^{8} cm^{-2} and the x-ray diffraction line width of the (400) InP peak was found to be 435 arc sec in annealed films. InP films of 3-4 μm in thickness exhibited specular morphology, low temperature photoluminescence line widths of 6-17 meV, and room temperature electron mobilities of 1900-2300 cm^2/V-s. The authors present initial results which indicate that optoelectronic devices utilizing a monolithic inP/Si technology are feasible.

51266 Impurity absorption coefficient measurements in phospbate glass melted under oxidizing conditions. Sapak, D.L (Schott Glass Technologies, Inc., Duryea, PA (US)); Ward, J.M.; Marion, J.e. pp. 107-112 of Properties and characteristics of optical glass. Marker, A.J. III. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). pp. 213 DOE Contract W-7405-ENG-48. (CONF-8808214--: Properties and characteristics of optical glass, San Diego, CA (USA), 18-19 Aug 1988).

This paper analyzes the contributions of individual impurities to the total absorption loss in phosphate laser glasses. The modification of conditions for melting of large castings of phosphate glass is discussed. Absorption coefficient measurements at the laser wavelength (1.05 μm) for most common transition metal impurities as well as platinum in phosphate laser glasses melted under the modern oxidizing conditions are presented.

51267 Simulated image maps for use in experimental high-resolution electron microscopy. O'Keefe, M.A. (National Center for Electron Microscopy, Univ. of California, Lawrence Berkeley Lab., CA (US)); Dahmen, U.; Hetherington, C.J.D. pp. 453-458 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

A map of all possible high-resolution images may be simulated for a crystalline specimen in a chosen orientation for any particular transmission electron microscope (HRTEM). These maps are useful during experimental high-resolution electron microscopy and make it possible to locate optimum imaging conditions even for foil thicknesses beyond the weak-phase object limit. Although defects such as grain boundaries are not generally periodic, image maps of perfect crystal can be used to optimize defect contrast during operation of the microscope by reference to the image of the perfect crystal neighboring the defect.

51268 Simulation and quantification of high-resolution Z-contrast imaging of semiconductor interfaces. Jesson, D.E. (Solid State Division, Oak Ridge National Lab., Oak Ridge, TN (US)); Pennycook, S.J.; Chisholm, M.F. pp. 439-446 of Atomic scale structure of interfaces: Materials Research Society symposium proceedings. Volume 159. Bringans, R.D.; Feenstra, R.M.; Gibson, J.M. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 477 (CONF-891119--: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

Incoherent characteristics of Z-contrast STEM images are explained using a Bloch wave approach. To a good approximation, the image is given by the columnar high- angle cross-section multiplied by the s-state intensity at the projected atom sites, convoluted with an appropriate resolution function. Consequently, image interpretation can be performed intuitively and quantitative simulation can be implemented on a small computer. The feasibility of column- by-column compositional mapping is discussed.

51269 Investigation of laser-surface interactions and optical damage mechanisms using excitation by pairs of picosecond laser pulses. Chase, L.L. (University of California, Lawrence Livermore National Laboratory, Livermore, CA (USA)); Lee, H.W.H.; Hughes, R.S. *Applied Physics Letters (USA)*, 57(5): 443-445 (30 Jul 1990). DOE Contract W-7405-ENG-48.

It is demonstrated that laser-surface interactions that cause optical surface damage of nominally transparent materials can be investigated by observing the effects of excitation by pairs of picosecond pulses separated by a variable time delay. Laser-induced emission of neutrals is used as the detection mechanism in the present experiments.

51270 Triggered energy releases in solid hydrogen hosts containing unpaired atoms. Collins, G.W. (Lawrence Livermore National Laboratory, Livermore, CA (USA)); Fearon, E.M.; Maienschein, J.L.; Mapoles, E.R.; Tsugawa, R.T.; Souers, P.C.; Gaines, J.R. *Physical Review Letters (USA)*, 65(4): 444-447 (23 Jul 1990). DOE Contract W-7405-ENG-48.

We have observed both triggered and spontaneous energy releases in tritiated solid hydrogens at temperatures above 1.2 K in several different experiments. These energy releases, which can be triggered by a temperature increase, were observed by monitoring the temperature excursion ("heat spike") versus time, the atom spin density, and nuclear-magnetic-resonance signal heights. The heat spikes correlate with a disappearance of free-atom spin density so that fast atomic recombination is the probable cause. The spontaneous heat spikes may be suppressed by improved heat extraction.

51271 Carrier density dependent photoconductivity in diamond. Pan, L.S. (Stanford Synchrotron Radiation Laboratory, P.O. Box 4349, Bin 99, Stanford, California 94309 (USA)); Kania, D.R.; Pianetta, P.; Landen, O.L. *Applied Physics Letters (USA)*, 57(6): 623-625 (6 Aug 1990).

Single-crystal natural diamonds have been intrinsically photoexcited using 2 ps laser pulses. Electron and hole mobilities and decay times are examined as a function of induced carrier density. Two major density dependent effects are observed. First, at high induced carrier densities, a dramatic decrease in the carrier mobility is observed. This is attributed to carrier-carrier scattering between the electrons and the holes. A model describing carrier-carrier scattering in silicon and germanium has been scaled to diamond. Second, the decay time of the electrons decreases as the initially photoexcited density increases. A simple one-level recombination model successfully explains this density dependence. The combination of these two effects results in a minimum in the measured photoconductive decay times.

51272 Intrinsic instability and entropy stabilization of grain boundaries. Fecht, H.J. (W. M. Keck Laboratory of Engineering Materials, California Institute of Technology, Pasadena, CA (USA)). *Physical Review Letters (USA),* 65(5): 610-613 (30 Jul 1990). DOE Contract FG03-86ER45242.

A simple method is proposed to describe the thermodynamic properties of disordered grain boundaries in nanocrystalline metals and semiconductors. Based on a free-volume approach at negative pressure of the universal equation of state, the maximum free volume, thermal expansion coefficient, specific-heat capacity, and excess enthalpy, entropy, and free energy of grain boundaries are derived from well-known thermodynamic relationships. The results show good agreement with available experimental data and suggest an intrinsic mechanical instability of a nanograin boundary (Gibbs instability) accompanied by divergences of α and c_p, and the possibility of an entropy stabilization of nanograin boundaries.

51273 Dynamic correlations in a classical two-dimensional Heisenberg antiferromagnet. Wysin, G.M. (Department of Physics, Cardwell Hall, Kansas State University, Manhattan, KS (USA)); Bishop, A.R. *Physical Review, B: Condensed Matter (USA),* 42(1): 810-819 (1 Jul 1990).

A Monte Carlo molecular-dynamics calculation of the dynamic structure function $S(\mathbf{q},\omega)$ for the classical two-dimensional isotropic Heisenberg antiferromagnet is presented. For wave vectors near the antiferromagnetic Bragg point, $S(\mathbf{q},\omega)$ is well described by a product of Lorentzians representing damped spin waves. For adequately low temperatures, the dependence of the spin-wave frequency and damping on wave vector and temperature are consistent with a dynamic scaling description of Chakravarty, Halperin, and Nelson. Even for higher temperatures a scaling description is quite well satisfied, but with a modified scaling frequency.

51274 Low-temperature catalysis of para-deuterium to ortho-deuterium conversion on Grafoil. Yucel, S. (Physics Department, Syracuse University, Syracuse, New York 13244 (USA)); Alexander, N.; Honig, A. *Physical Review, B: Condensed Matter (USA),* 42(1): 820-825 (1 Jul 1990). DOE Contract FG02-84ER53179.

Para-deuterium to ortho-deuterium conversion rates were determined on Grafoil in the temperature range of 10 to 27 K. Above 10 K the measured conversion rates in the two-dimensional (2D) solid regimes are almost independent of temperature, with a gradual slow-down occurring at higher temperatures in "2D gas" and "2D fluid" phases. The observed weak temperature dependence as well as the magnitude of the conversion rate are consistent with a recent theoretical analysis of low-temperature ortho-para conversion via emission of 2D solid-D_2 phonon(s). Measurements in the "2D gas" phase suggest that this phase is a lattice gas. This is supported by a calculation of the ratio of the conversion rate in a lattice gas to that in a Debye solid, which is in reasonable agreement with our measured ratio. Application of our results to catalytic purification of ortho-D_2 is discussed in terms of ortho-D_2 purity requirements for metastably nuclear-spin-polarized solid D_2, useful as a nuclear fusion fuel or a polarized target for particle-physics experiments.

51275 Evidence against surface nucleation following pulsed melting of Si. Peercy, P.S. (Sandia National Laboratories, P. O. Box 5800, Albuquerque, NM (USA)); Tsao, J.Y.; Thompson, M.O. *Journal of Materials Research (USA),* 5(7): 1463-1467 (Jul 1990).

Time-dependent measurements of the melt and solidification behavior of amorphous Si, formed by ion implantation of In, have been obtained following irradiation with ~3 ns ruby laser pulses. The recently observed buried In sheets formed under such conditions are shown to result from internal nucleation of melt, contrary to previous interpretations. Under no conditions was surface nucleation of either amorphous or crystalline Si observed from a surface melt. These results resolve previous inconsistencies in the understanding of phase formation during rapid melting and solidification of Si.

51276 The effect of temperature on the chemistry and morphology of the interphase in an SCS6/Ti-6Al-4V metal matrix composite. Jones, C. (National Centre for Composite Materials Research, Talbot Laboratory, University of Illinois, Urbana, IL (USA)); Kiely, C.J.; Wang, S.S. *Journal of Materials Research (USA),* 5(7): 1435-1442 (Jul 1990). DOE Contract AC02-76ER01198.

The changes in the chemistry and morphology within the interphase region of an SCS6-Ti-6Al-4V metal matrix composite upon exposing the samples to varying heat treatments have been studied using Auger electron spectroscopy, TEM and convergent beam diffraction techniques. These changes, such as, the formation of small TiC particles at one interface, and the narrowing of a protective pyrocarbon layer at another, induce fracture to occur at different places within the interphase upon heating. The reasons for this are explained. Evidence for a change in phase of a $Ti_xSi_y(C)$ layer to the more thermodynamically stable Ti_5Si_3 is also given.

51277 Consequences of simultaneous exposure of inorganic solids to excimer laser light and an electron beam. Dickinson, J.T. (Department of Physics, Washington State University, Pullman, WA (USA)); Langford, S.C.; Jensen, L.C.; Eschbach, P.A.; Pederson, L.R.; Baer, D.R. *Journal of Applied Physics (USA),* 68(4): 1831-1836 (15 Aug 1990). DOE Contract AC06-76RL01830.

In previous work we examined the changes in surface topography of sodium trisilicate glass ($Na_2O{\cdot}3SiO_2$) with exposure to pulsed 248-nm excimer laser light at fluences of 2.6–5 J/cm^2 (per laser pulse), as well as the character of the products emitted from the glass surface (e.g., $\pm$ ions, electrons, ground state and excited neutral atoms and molecules). At fluences above a threshold, ablative etching occurs only after a number of preliminary laser pulses. In this work, we show a dramatic synergism in the ablation process by simultaneous bombardment of the glass surface with 0.5–2 keV electrons *and* laser pulses. Extensive etching can be initiated immediately and sustained indefinitely at subthreshold fluences. Reflection electron energy loss spectroscopy performed on electron-bombarded surfaces shows band gap states growing with exposure. We propose that surface and near-surface defects produced by inelastic scattering of the electron beam provide single-photon absorption centers, facilitating etching at subthreshold fluences. The potential for single-photon driven etching/ablation of other wide band gap dielectric materials is also discussed. These studies also support the hypothesis that etching and damage of such surfaces can occur after prolonged exposure to laser irradiation alone due to an accumulation of absorption centers.

51278 Modeling the memory retention characteristics of silicon-nitride-oxide-silicon nonvolatile transistors in a varying thermal environment. McWhorter, P.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Miller, S.L.; Dellin, T.A. *Journal of Applied Physics (USA),* 68(4): 1902-1909 (15 Aug 1990).

The memory retention characteristics of silicon-nitride-oxide-silicon nonvolatile memory devices are found to be strongly thermally activated. A model is developed based on thermal emission of charge from traps. This model accurately predicts the threshold voltage decay of transistors stored in varying thermal environments. The model is demonstrated to be accurate over 7 decades of time and for temperatures between −40 and 200 °C.

51279 Structural and dynamical properties of the sol-gel transition. Winter, R. (Univ. of Illinois, Urbana (USA)); Hua, D.W.; Song, X.; Mantulin, W.; Jonas, J. *Journal of Physical Chemistry (USA),* 94(6): 2706-2713 (22 Mar 1990).

A variety of experimental techniques (multinuclear NMR, Raman, fluorescence polarization, small-angle neutron scattering, viscosity, turbidity, static and dynamic light scattering experiments) have been employed to investigate the nature of the sol-gel transition of tetramethoxysilicate, $Si(OCH_3)_4$ (TMOS). The experiments probe changes in structural and dynamical properties at the macroscopic and microscopic levels in the course of the sol-gel transition. The experimental results are compared with recent theories for the gelation process. The experiments show that no drastic change in structure occurs at the gelation threshold of TMOS.

51280 Thiol surface complexation on growing CdS clusters. Swayambunathan, V. (Argonne National Lab., IL (USA)); Hayes, D.; Schmidt, K.H.; Liao, Y.X.; Meisel, D. *Journal of the American Chemical Society (USA),* 112(10): 3831-3837 (9 May 1990). DOE Contract W-31-109-ENG-38.

The growth of small CdS colloidal particles has been initiated by pulse radiolytic release of sulfide from thiol (3-mercapto-1,2-propanediol, RSH) in the presence of Cd^{2+} ions. The kinetics and

stoichiometry of the ensuring reactions were followed by conductivity, absorption spectroscopy, and light-scattering techniques. The final CdS product has been identified by electron diffraction. The formation of Cd-thiolate complexes at the surface of the particles is indicated by conductivity and by energy dispersive analysis of X-ray (EDAX) results. The rate of formation of CdS clusters is strongly pH dependent due to the pH effect on the stability of Dd^{2+}/HS^- complexes. At low pHs (4.0-5.3) the growth mechanism is proposed to be primarily a cluster-molecule process. At this pH range Cd^{2+} ions at the CdS particle surface complex with thiolate ions stronger than in the bulk of the solution. The size control of the particles by thiols is proposed to result from a competition of thiolate ions with HS^- ions for cadmium ions at the surface of the growing particles.

51281 **Process for direct conversion of reactive metals to glass.** Rajan, J.B.; Vissers, D.R. To Dept. of Energy, Washington, DC (USA). USA Patent 4,898,692/A/. 6 Feb 1990. Filed date 16 Nov 1988. USA Patent patents application 7-271,967. Int. Cl. G21F 9/16. 6p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes radioactive alkali metal introduced into a cyclone reactor in droplet form by an aspirating gas. In the cyclone metal reactor the aspirated alkali metal is contacted with silica powder introduced in an air stream to form in one step a glass. The sides of the cyclone reactor are preheated to ensure that the initial glass formed coats the side of the reactor forming a protective coating against the reactants which are maintained in excess of 1000° C. to ensure the formation of glass in a single step.

40 CHEMISTRY

Refer also to citation(s) 52582

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51282 (AERE-R-13030) **Application of X-ray absorption edge spectrometry to the non-destructive determination of element concentrations, coating thickness and areal densities.** Taylor, B.L.; Russen, L.C.; Metcalfe, B. UKAEA Harwell Lab. (UK). Nuclear Physics and Instrumentation Div. Nov 1988. 15p. Source: Available from H.M. Stationery Office, London, Price Pound 8.00.

X-ray absorption edge spectrometry is a relatively new technique for measuring the thickness of films and coatings. It can also be used to determine the concentration of the heavier elements in a low atomic number matrix. Although the method has important limitations with regard to the sample types that can be measured, recent developments in equipment have extended the area of applicability and have also made it possible to carry out on-line measurements on samples in hostile or inaccessible environments such as vacuum vessels, furnaces, or radioactive areas, where other methods would be difficult if not impossible to apply. (author).

51283 (CONF-9006271–1) **Laser desorption/photoionization time-of-flight mass spectrometry of polymer additives.** Hunt, J.E.; Lykke, K.R.; Pellin, M.J. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From NATO advanced research workshop on methods and mechanisms for producing ions from large molecules; Ontario (Canada); 24-28 Jun 1990. Order Number DE90017808. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Laser desorption mass spectrometry has proven to be a very useful tool in the analysis of non-volatile organic materials. Laser desorption (LD) along with other mass spectrometric techniques such as fast atom bombardment and ^{235}Cf-plasma desorption have greatly extended the ability of mass spectroscopy to characterize complex substances. Laser desorption with a single laser wavelength has achieved some success in analysis of organic polymer additives. In this case the desorption laser also acts as the ionization laser, limiting the ion yield, and ultimately, the sensitivity. Furthermore, the ion yield may depend critically on the matrix, as demonstrated in matrix-assisted laser desorption of proteins. Earlier work has suggested that a two-laser scheme, separating the desorption step from the ionization step, can be useful in characterizing complex substances. In this work we describe a laser desorption/photoionization time-of-flight mass spectrometer (LD/PI TOF) and the feasibility of laser desorption coupled with photoionization of neutrals for characterization of polymer additives. Present day polymers are complex mixtures of not only the base polymer, but also many additives which determine the characteristics of the polymer in a critical way. The analysis of polymer additives by mass spectrometry has remained a considerable challenge because of the complexity of commercial polymer formulations. The main advantage of this technique results from the separation of the desorption and ionization processes. Furthermore, separation of the desorption and ionization steps offers possibilities for the investigation of the desorption process. We also present some information about the initial velocity distributions of desorbed neutral species obtained with our LD/PI TOF spectrometer.

51284 (CONF-9006271–2) **Matrix-assisted laser desorption fourier transform mass spectrometry for biological compounds.** Hettich, R.; Buchanan, M. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From NATO advanced research workshop on methods and mechanisms for producing ions from large molecules; Ontario (Canada); 24-28 Jun 1990. Order Number DE91000393. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The recent development of matrix-assisted UV laser desorption (LD) mass spectrometry has made possible the ionization and detection of extremely large molecules (with molecular weights exceeding 100,000 Daltons). This technique has generated enormous interest in the biological community for the direct examination of large peptides and oligonucleotides. Although this matrix-assisted ionization method has been developed and used almost exclusively with time-of-flight (TOF) mass spectrometers, research is currently in progress to demonstrate this technique with trapped ion mass spectrometers, such as Fourier transform ion cyclotron resonance mass spectrometry (FTMS). The potential capabilities of FTMS for wide mass range, high resolution measurement, and ion trapping experiments suggest that this instrumental technique should be useful for the detailed structural characterization of large ions generated by the matrix-assisted technique. We have recently demonstrated that matrix-assisted ultraviolet laser desorption can be successfully used with FTMS for the ionization of small peptides. The objective of this report is to summarize the application and current limitations of matrix-assisted laser desorption FTMS for the characterization of peptides and oligonucleotides at the isomeric level. 4 refs., 3 figs., 2 tabs.

51285 (CONF-9011110–1) **Application of diode lasers to resonance ionization mass spectrometry.** Young, J.P.; Shaw, R.W.; Smith, D.H. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From DOE workshop on advanced laser technology for chemical measurements; Oak Ridge, TN (USA); 12-14 Nov 1990. Order Number DE91000614. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Detailed studies of the application of diode lasers to resonance ionization mass spectrometry (RIMS) have been made. These devices were used to excite the first transition of several 1+1+1 multiple photon processes for both lanthanum 138 and 139. Enhanced isotopic selectivity resulted; very-high resolution spectra were also obtained with the diode laser step to yield new atomic hyperfine structure constants. 4 refs., 3 figs.

51286 (CONF-9011110–2) **Resonance ionization of rubidium in an ion trap mass spectrometer.** Whitten, W.B.; Ramsey, J.M.; Goeringer, D.E.; Buckley, B.T. Oak Ridge National Lab., TN (USA). [1990]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From DOE workshop on advanced laser technology for chemical measurements; Oak Ridge, TN (USA); 12-14 Nov 1990. Order Number DE91000613. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

We have recently initiated a study of resonance ionization processes in a quadrupole ion storage trap. The trap is a commercially available Ion Trap Detector that uses the voltage dependence of ion mass instability to obtain a mass spectrum of the trapped ions. We have modified the trap to permit laser excitation of atomic and molecular species within the quadrupole electrodes. Mass resolved resonance ionization spectra have been obtained for NO and Rb, described below. Rb was selected for this study for a number of reasons. We want to explore the potential of the ion trap for high resolution (Doppler free) resonance ionization spectroscopy with CW laser excitation. Rb can be excited to upper Rydberg levels with a series of transitions that can be induced with commercially available semiconductor diode lasers. In addition, levels in the same energy range can be reached through two-photon processes with visible wavelength tunable dye lasers or with single-photon processes after the laser is frequency doubled. The upper Rydberg levels can be ionized by photons, electric field, or collisions. Collisional ionization of a reservoir of Rydberg atoms may be a sensitive scheme for detecting electronegative species. RB has two stable isotopes with nonzero nuclear spin so that isotopic and hyperfine splittings can be used to assess the spectral resolution that is attained.

51287 (CONF-9011110–3) **Ultrasensitive molecular fluorescence spectroscopy in levitated microdroplets.** Ramsey, J.M. (Oak Ridge National Lab., TN (USA)); Whitten, W.B.; Arnold, S.; Bronk, B.V. Oak Ridge National Lab., TN (USA). [1990]. 3p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From DOE workshop on advanced laser technology for chemical measurements; Oak Ridge, TN (USA); 12-14 Nov 1990. Order Number DE91000621. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The extreme sensitivity of fluorescence spectrophotometry results from the fact that a molecule can undergo many excitation-emission cycles before destruction by photochemical degradation. For example, Rhodamine 6G (R6G) can emit in excess of 10^5 photons before photolysis takes place. The fraction of emitted photons collected and converted to countable pulses can be as high as 10^{-3}, although 10^{-4} is more readily attainable. Therefore, sufficient signal exists for single molecules to be detectable. Detection limits for molecules in solution have been limited by background signal from solvent Raman scattering and fluorescence. This background signal adds noise to the measurement and has effectively restricted the detectable concentration to about 10^{-13} M. Over the past decade, advances in detection of fewer molecules have all been made by reducing the measurement volume and/or increasing the measuring time. Given the above concentration detection limit a reduction of the measurement volume to 1 pL leads to a minimum observable quantity of $\approx$1 molecule. The ability to detect a single molecule in condensed phase could have many important applications in addition to being an interesting problem. The obvious application of this approach is to situations where small quantities of material are available for analysis. The capability to reliably detect a single fluorophore might also allow the screening and/or sorting of a collection of molecules. Such abilities would have application to many biological problems such as DNA sequencing and detection of DNA adducts.

51288 (IS–5002) **Determination of neptunium-237 in complex matrices by high-resolution inductively coupled plasma–atomic multielement emission spectroscopy (ICP–AMES).** DeKalb, E.L.; Edelson, M.C. Ames Lab., IA (USA). Sep 1989. 60p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-82. Order Number DE90017261. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Np-237 is determined sensitively by inductively coupled plasma – atomic multielement emission spectroscopy (ICP-AMES). Detection limits of intense Np emission lines and the hyperfine broadening of these lines are reported. The most sensitive line, at 382.9 nm, has a detection limit of 25 ppb (i.e., 25 ng/ml) and is split by hyperfine effects into six resolvable components. Lines at 430.7 nm and 382.9 nm can be used to determine Np in complex U-containing solutions, such as spent fuel dissolver solution, at concentrations of 0.05 and 0.1% (relative to U) respectively. ICP-AMES, with a photodiode array detector, is used for real-time, simultaneous, multielemental monitoring of solutions eluting from ion-exchange columns. The added selectively provided by combining ion-exchange chromatography with high-resolution ICP emission spectroscopy results in improved Np detectability. Np, in a simulated D5 fuel dissolver solution, was determined at a concentration of <50 ppm relative to U. The detection limit for determining Np in a U-rich matrix by monitoring its emission at 382.9 nm is estimated to be 1 ppm relative to U. 29 refs., 25 figs., 8 tabs.

51289 (KFK–4712) **ELAN - expert system supported information and management system for analytical laboratories.** Orth, H.; Zilly, G. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Schadstoffbeherrschung in der Umwelt (PSU). May 1990. 14p. (In German). Order Number DE91705962. Source: NTIS (US Sales Only), PC A03/MF A01.

The demand for high efficiency and short response time calls for the use of computer support in chemico-analytical laboratories. This is usually achieved by laboratory information and management systems covering the three levels of analytical instrument automation, laboratory operation support and laboratory management. The management component of the systems implemented up to now suffers from a lack of flexibility as far as unforeseen analytical investigations outside the laboratory routine work are concerned. Another drawback is the lack of adaptability with respect to structural changes in laboratory organization. It can be eliminated by the application of expert system structures and methods for the implementation of this system level. The ELAN laboratory information and management system has been developed on the basis of this concept. (orig.).

51290 (LA-UR–90-3247) **High ionization efficiency techniques for CW RIMS.** Fearey, B.L.; Johnson, S.G.; Miller, C.M. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009174–5: 5. international symposium on resonance ionization spectroscopy and its applications, Varese (Italy), 16-21 Sep 1990). Order Number DE91000217. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The demand to measure high dynamic range isotope ratios on small samples with RIMS continues to increase. This paper discusses high ionization efficiency methods which can be applied to CW RIMS to potentially achieve several tens of percent ionization efficiencies for certain elements. The primary technique under development to achieve this is an external laser cavity which can generate very high circulating laser powers.

51291 (LBL–26455, pp. 57-58) **Local modes of benzene and benzene dimer, studied by infrared-ultraviolet double resonance in a supersonic beam.** Page, R.H.; Shen, Y.R.; Lee, Y.T. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The authors have reported on what they believe to be the first high-resolution, state-selective study of local modes in a relatively large molecule-benzene. The technique they used was a combination of rotational cooling in a supersonic beam expansion and multilevel, state-selective saturation spectroscopy. There is no doubt that the room-temperature local-mode overtone spectra of large molecules previously published have had inhomogeneous congestion. Broad rotational envelopes and hot bands appear to be the culprits. Linear absorption measurements on room-temperature samples simply cannot uncover the wealth of detail present in the spectra. Many suspected but heretofore undetected perturbations between the local and other vibrational modes obviously occur. Judging from the appearances of the overtone spectra of the monomer and dimer, they conclude that the local-mode description of the benzene C-H stretches applies to $\nu \leq 3$. Their linewidth measurements show that the lifetimes of the C-H stretching vibration exceed a few psec, even at a total energy of $\sim$ 8,800 cm^{-1}. This is an accordance with lifetime data on other vibrational modes of benzene excited to similar energies. In the absence of direct lifetime measurements of the local-mode states, these lifetime estimates based on the measured linewidths are likely to be

only a lower bound. Their measurements of the C-H stretching spectra of the benzene dimer could help to resolve questions concerning its intermolecular potential, structure, and vibrational predissociation lifetime.

51292 (LBL–26455, pp. 58) **Infrared-ultraviolet double-resonance studies of benzene molecules in a supersonic beam.** Page, R.H.; Shen, Y.R.; Lee, Y.T. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The authors have used the powerful, elegant double-resonance technique to study a prototype intermediate-size molecule (benzene) cooled in a supersonic expansion. The thorough work that has already been done on the $\tilde{X}$ vibrations and the $\tilde{A} \leftarrow \tilde{X}$ transition of benzene allowed them to make decisive assignments of several IR-pumping-induced UV transitions. With these assignments, they were able to confirm, in a qualitative way, Pliva's analysis of the C-H stretching Fermi tetrad in the $\tilde{X}$ state. Also, they provided a determination of the gas-phase value of ν'_{19}, the IR-active C-H bend, and the first observation in the $\tilde{A}$ state of ν_3, the C-H libration, and of ν_{20}, the IR-active C-H stretch. The values of these frequencies are found to be $\nu'_{19} \cong 1{,}045\ cm^{-1}$, $\nu'_3 \approx 1{,}327\ cm^{-1}$, and $\nu_{prime20} \approx 3{,}084\ cm^{-1}$. A thorough understanding of the first excited state of a simple phenyl system could prove useful in several situations. For example, phenyl rings form the basis of many (e.g., laser) dyes. Enhancements in lasing efficiency and photochemical stability could perhaps be engineered with better knowledge of excited-state geometries and forces.

51293 (LBL–26455, pp. 58) **High-resolution photoionization spectrum of water molecules in a supersonic beam.** Page, R.H.; Larkin, R.J.; Shen, Y.R.; Lee, Y.T. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The authors have obtained high-resolution ($\sim 1.5\ cm^{-1}$) photoionization spectra of supersonically cooled ($T_{rot} \sim 50$ K) H_2O and D_2O in the 1,000-900 Å range. The light source, which used the technique of frequency tripling in a pulsed free jet of gas, is described briefly. Spectra are rotationally resolved. Vibrationally excited autoionizing Rydberg series converging to the ground electronic state of the molecular ion are detected. This may well be the first example of a highly resolved Rydberg spectrum of a stable polyatomic atomic molecule. From the convergence limit, the ionization potential H_2O is determined to be $101{,}777 \pm 7\ cm^{-1}$. Intensities of the Rydberg-state autoionization signals are smaller than predicted with known Franck-Condon factors, indicating that predissociation is a competitive decay channel. Rydberg-state lifetimes are ~ 1 psec, deduced from homogeneous linewidths. Autoionizing features from Rydberg states associated with the ion's quasilinear state are observed with linewidths above $10\ cm^{-1}$, indicating that their lifetimes are less than ~ 0.5 psec. Rotational assignments of some of the bands in this linear $\leftarrow$ bent transitions show that the Rydberg and ionic-state geometries are nearly identical. A consistent assignment of the controversial bending (ν_2) quantum number and Rydberg series quantum defect $\delta = -0.037$ have been provided.

51294 (LBL–29360) **Development of a calibration method for quantitative x-ray powder diffraction of size-segregated aerosols.** Giauque, R.D.; Jaklevic, J.M.; Sindelar, L.E. Lawrence Berkeley Lab., CA (USA). Jul 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9007149–3: 39. annual Denver x-ray conference, Steamboat Springs, CO (USA), 30 Jul - 3 aug 1990). Order Number DE91000227. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

X-ray power diffraction (XPD) is an important tool for the chemical characterization of atmospheric aerosol samples particularly when combined with elemental analysis obtained from x-ray fluorescence (XRF) measurements of the same specimen. The present study focuses on evaluating potential problems associated with XPD analysis of thin layers of particles collected on membrane filters such as would be the case for atmospheric aerosol samples and certain other classes of environmental and geological samples. These samples differ from those previously investigated in quantitative XPD in that absorption effects are minimized but particle size and preferential alignment artifacts may be more significant. The current US Environmental Protection Agency (EPA) aerosol monitoring programs emphasize the use of sampling devices which collect size-segregated aerosols of aerodynamic equivalent diameter less than 10 μm. The approach used in the present experiments is to prepare thin deposits of size-segregated particles and compare the extent to which conventional thin film XRF calibration methods can be applied to quantitative XPD analysis. 13 refs., 1 fig., 7 tabs.

51295 (MLM–3654) **Mound activities in chemical and physical research: January–December 1989.** EG and G Mound Applied Technologies, Miamisburg, OH (USA). Sep 1990. 69p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90018033. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report discusses research in four areas of Mound Activities. The areas are: Separation Research, Transport Property Research, Low Temperature Research and Data Treatment. (JDL)

51296 (NRC–29895) **Advances in reverse osmosis and ultrafiltration.** Matsuura, T.; Sourirajan, S. (eds.). National Research Council of Canada, Ottawa, ON (Canada). 1989. 598p. (CONF-8806495–: Symposium on advances in reverse osmosis and ultrafiltration, Toronto (Canada), 7-10 Jun 1988; CE–03179). Source: Canada Institute for Scientific and Technical Information, Montreal Rd., Ottawa, ON, CAN K1A 0R6. Prices: PRICES UPON REQUEST.

A conference was held to discuss recent advances in reverse osmosis and ultrafiltration. Papers were presented in the areas of membrane development and module design, membrane transport and membrane characterization, membrance gas transport and pervaporation, and membrane applications in water treatment, biotechnology and food processing. Separate abstracts have been prepared for 3 papers from this conference.

51297 (ORNL/FTR–3765) **[Resonance ionization spectroscopy and its applications]: Foreign trip report, September 15, 1990–September 22, 1990.** Payne, M.G. Oak Ridge National Lab., TN (USA). 5 Oct 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000691. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The field of Resonance Ionization Spectroscopy grew out of work done in the Photophysics Group at Oak Ridge National Laboratory. As one of the original developers of this field the traveler has continued to attend this meeting on a regular basis. The traveler was originally asked to present an invited talk and to present part of a short course offered to graduate students attending the conference. Subsequently, the traveler was also asked to chair a session and to be a judge of the students papers entered in a contest for a $1000 first prize.

51298 **X-ray film calibration: Dynamic range modification for imaging and spectroscopy.** Stone, G.F. (Lawrence Livermore National Lab., CA (USA)); Dittmore, C.H.; Henke, B.L. pp. N31 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the use of silver halide x-ray films for imaging and spectroscopy which is limited by the range of intensities that can be recorded and densitometered. Using the manufacturers processing techniques can result in 10^{2-3} range in intensity recorded over 0-5 density range. By modifying the chemistry and processing times, ranges of 10^{5-6} can be recorded in the same density range. The authors report on x-ray film calibration work and dynamic range improvements. Changes to the processing chemistry and the resulting changes in dynamic range and x-ray sensitivity are discussed.

51299 **Applications of image analysis for infrared microspectroscopic detection of contaminants on microelectronic devices.** Ward, K.J. (Sandia National Lab., Albuquerque,

NM (US)). pp. 212-213 of Proceedings of the 7th international conference on Fourier transform spectroscopy: Volume 1145. Cameron, D.G. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 642 (CONF-890674–: 7. international conference on Fourier transform spectroscopy, Fairfax, VA (USA), 19-23 Jun 1989).

The use of infrared microscopy imaging for location and identification of contaminants on microelectronic devices is discussed. Several methods for reconstruction of images from the spectrum acquired at each pixel were compared. Peak-height and peak-integration methods require prior knowledge of the contaminant to narrow the spectral region of interest. These frequency-limited methods performed better than full-spectrum methods. When full-spectrum methods must be used, Gram-Schmidt reconstruction performed better than integration.

51300 X-ray studies of the liquid/vapor interface: Water and polymer and fatty acid monolayers on water. Schlossman, M.L. (Dept. of Physics and Division of Applied Sciences, Harvard Univ., MA (US)); Schwartz, D.K.; Kawamoto, E.H.; Kellogg, G.J.; Pershan, P.S.; Ocko, B.M.; Kim, M.W.; Chung, T.C. pp. 351-362 of Macromolecular liquids: Materials Research Society symposium proceedings. Volume 177. Safinya, C.R.; Safran, S.A.; Pincus, P.A. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 427 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

X-ray specular reflectivity is used to study the liquid-vapor interface of pure water and of fatty acid and polymer monolayers at that interface. For the pure water surface the reflectivity was measured for three different spectrometer resolutions and simultaneous fits with only one free parameter to all of the data are in excellent agreement with the prediction of capillary wave theory for the RMS surface roughness. Diffuse scattering away from the specular condition, at wavevectors corresponding to those of the capillary waves, yields intensities and line shapes in agreement with theory with no significant adjustable parameters. Reflectivity from separate monolayers of co-poly 1,2-butadiene/butyl alcohol (50% random substitution) and lignoceric acid ($CH_3(CH_2)_{22}COOH$) at the water/vapor interface are intraperated to obtain profiles of the average electron density $\rho(z)$ as a function of distance z along the surface normal.

51301 Diblock copolymers at surfaces. Green, P.F. (Sandia National Labs., NM (US)); Christensen, T.M.; Russell, T.P.; Anastasiadis, S.H. pp. 317-328 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper investigates the surface properties of symmetric microphase separated diblock copolymers of polystyrene (PS) and polymethylmethacrylate (PMMA) by using X-ray photoelectron spectroscopy (XPS), the specular reflectivity of neutrons and secondary ion mass spectrometry (SIMS). PS, the lower surface energy component, exhibited a preferential affinity for the free surface. For copolymers that are far from the bulk microphase separation transition (MST), the surface consists of a layer of pure PS. When the system is close to the MST the surface is a mixture of PS and PMMA. The PS surface excess can be described by a $N^{-1/2}$ dependence, where N is the number of segments that comprise the copolymer chain. It is shown that the surface undergoes and ordering transition at a temperature T_s that is above that of the bulk MST. The ordering of the bulk lamellar morphology is induced by an ordering at the surface. This is analogous to the ferromagnetic order observed in systems such as Gd at temperatures above the bulk Curie temperature. The results are discussed in light of previous work on copolymer surfaces and in light of mean field theory.

51302 X-ray reflectivity and fluorescence measurements from polystyrene-co-bromostyrene/polystyrene interfaces. Sokolov, J. (Queens College, NY (US)); Rafailovich, M.; Zhao, X.; Yun, W.B.; Jones, R.A.L.; Kramer, E.J.; Composto, R.J.; Stein, R.S.; Bommannavar, A.; Engbretson, M. pp. 337-342 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper discusses the use of X-ray fluorescence using synchrotron radiation at glancing angles of incidence to measure interface widths of the highly immiscible polymer blend system polystyrene/polybromostyrene (PS/PBr_xS, with bromination level x = 0.8 bromine atoms per monomer). The interfacial widths are for bilayers annealed for 4 hours and 24 hours at 141±1°C are found to be 100±20Å and 110±20Å respectively.

51303 Neutron reflection study of surface enrichment in an isotopic polymer blend. Jones, R.A.L. (Cavendish Lab., Cambridge Univ. (GB)); Norton, L.J.; Kramer, E.J.; Composto, R.J.; Stein, R.S.; Russell, T.P.; Felcher, G.P.; Mansour, A.; Karim, A. pp. 335-336 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper measures neutron reflectivities from the surface of films of deuterated polystyrene (d-PS) and protonated polystyrene (PS) blends before and after annealing, and uses the results to determine the concentration versus depth profile of the films. After annealing, the surface is enriched in d-PS, with a surface excess proportional to the bulk concentration of d-PS, in agreement with previous measurements using forward recoil spectrometry. The decay of the enhanced concentration into the bulk occurs over a length approximately equal to the bulk correlation length (~200 Å), in close agreement with that predicted by current mean-field theory.

51304 On the scale of diffusion lengths observable by neutron reflection: Application to polymers. Karim, A. (Argonne National Lab., IL (US)); Mansour, A.; Felcher, G.P.; Russell, T.P. pp. 329-334 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper discusses a systematic approach applied to neutron reflectivity data to study interdiffusion across an interface. It is shown that with this technique it is possible to probe interface broadening from ~10Å to upward of 200 Å, the upper limit being already within the range of observation of other techniques such as Rutherford backscattering spectrometry (RBS), forward recoil spectrometry (FRES) and secondary ions mass spectroscopy (SIMS). As example is analyzed the interdiffusion of a bilayered polymer system: a deuterated polystyrene (d-PS) layer on protonated polystyrene (h-PS).

51305 X-ray near total external fluorescence method: Experiment and analysis. Yun, W.B. (Argonne National Laboratory, Advanced Photon Source/ Material Science Division, 9700 South Cass Avenue, Argonne, IL (USA)); Bloch, J.M. *Journal of Applied Physics (USA)*, 68(4): 1421-1428 (15 Aug 1990). DOE Contract W-31109-ENG-38.

The synchrotron x-ray near total external fluorescence technique is used to measure the concentration profiles of elements near a sample surface along its surface normal. This novel nondestructive technique is capable of providing information about the concentration profiles on a length scale of tens to hundreds of angstroms from the sample surface. It does not require vacuum and can be applied at ambient pressures. Concentration profiles of virtually all the elements in the periodic table can be investigated using this technique. The lower limit of detection is approximately equivalent to (1)/(10) of a monolayer coverage. The technique is particularly useful in applications where the fluorescence signal originating from a thin surface layer can be normalized against that originating from the same element in the bulk of the sample. The experimental procedure and the data analysis are demonstrated using experimental results of metal-ion segregation from a liquid solution to a liquid/air interface.

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Refer also to citation(s) 50325, 50452, 50453, 50554, 50713, 50714, 50771, 51128, 51129, 51134, 51157, 51161, 51169, 51198, 51200, 51211, 51250, 51260, 51262, 51295, 51728, 51766, 52001, 52002, 52004, 52312, 52342

51306 (DOE/ER/13852–188) **Studies of radiation-produced radicals and radical ions: Progress report, August 1, 1987–August 31, 1990.** Williams, T.F. Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry. [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13852. Order Number DE90017841. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report briefly discussed the personnel facilities and equipment, and publications for the radiation-produced radicals and radical ions program. (JDL)

51307 (DOE/ER/13852–T1) **Electron spin resonance spectroscopic studies of radical cation reactions.** Dai, Sheng. Tennessee Univ., Knoxville, TN (USA). Dec 1990. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13852. Order Number DE90017894. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The general theory developed in Chapter 2 is applied in this chapter to elucidate two dynamic ESR problems encountered in our radical cation studies. The first problem is the dynamic conformational change of ring-closed oxirane radical cation, while the second is concerned with the dynamic characterization of the electron transfer between the methyl viologen dication (MV^{2+}) and its radical cation ($MV^{+\cdot}$).

51308 (HCR-CDM–11) **Catalytic properties of mineral ion-exchangers previously used in uranium ore wastes treatment. I. Ammoniac octylation in gaseous phase using Y-type faujasite catalysts containing mainly uranium.** Azzouz, A.; Nibou, D.; Abbad, B.; Achache, M. Haut Commissariat a la Recherche, Algiers (Algeria). Centre de Developpement des Materiaux. Jun 1990. 10p. (In French). Order Number DE91603443. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Scientific communication presented at: Premier colloque Franco-Maghrebin sur la catalyse Hammamet (Tunisia) 4-8 June 1990.

Y-type faujasite, previously used in purifying aqueous wastes containing radioactive elements, are studied as catalysts in heterogeneous reactions such as octanol amination. This process consists in alkylating ammoniac NH_3 by octanol-1 in a flow reactor containing a fixed bed of pelleted catalysts. Acidic catalysts like Y-type faujasite impregnated with low concentration leaching solution containing between 10 and 1000 ppm of uranium show interesting activities and selectivities in yielding primary, secondary and tertiary amines. High octanol conversions were obtained reaching 60 mol.% for appreciable selectivities for producing amines of about 60-80 mol.%. Compared to the non-active fresh zeolite, the catalysts obtained present good activities essentially due to the presence of uranyl cations UO_2^{++}. The latter seems to play the main role in activating the zeolite by enhancing its Bronsted surface acidity. Another interest of this process consists in obtaining Trioctylamine (TOA), an important extraction agent in uranium hydrometallurgy or its derivatives (MOA and DOA) which are very used in chemical industry.

51309 (HCR-CDM–12) **Extraction of molybdenum VI by alpha benzoinoxime.** Achache, M.; Meklati, M. Haut Commissariat a la Recherche, Algiers (Algeria). Centre de Developpement des Materiaux. Jun 1990. 9p. (In French). Order Number DE91603445. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The concentration of molybdenum, was studied using alpha benzoinoxime dissolved in chloroform. Several acids and salt at different levels of concentration were investigated as well as other parameters such as (mixing time, extractant to metal ratio, temperature etc.) The molybdenum stippling was also studied in alkaline medium with the subsequent recovery of the extractant and solvent.

51310 (LA-UR–90-3264) **Transuranic organometallics: The next generation.** Zwick, B.D.; Sattelberger, A.P.; Avens, L.R. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900846–4: International symposium to commemorate the 50th anniversary of discovery of transuranium elements, Washington, DC (USA), 26-31 Aug 1990). Order Number DE91000212. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Neptunium and plutonium metal react cleanly with 3/2 equiv. I_2 in aprotic ligating solvents, L, such as tetrahydrofuran (THF), pyridine (Py), and dimethylsulfoxide (DMSO) to give the triiodide complexes as tetrasolvates, $AnI_3(L)_4$ (An = Np, L = THF (1)); An = Pu, L = THF (2a), Py (2b), and DMSO (2c). These triiodide complexes are convenient precursors to new transuranic compounds. Reaction of the triiodide complexes 1 and 2a hexane with 3 equiv. of sodium bis(trimethylsilyl)amide give the volatile, solvate-free tris(silylamide) complexes, $An[N(SiMe_3)_2]_3$ (An = Np, 3; An = Pu, 4). The silylamide complexes 3 and 4 undergo rapid reaction in hexane upon stoichiometric addition of $HO\text{-}2,6\text{-}(t\text{-}C_4H_9)_2C_6H_3$ to give the aryl oxide complexes $An[O\text{-}2,6\text{-}(t\text{-}C_4H_9)_2C_6H_3]_3$ (An = Np, 5; An = Pu, 6). Preliminary investigations suggest that the aryl oxide complexes 5 and 6 react with lithium bis(trimethylsilyl)methanide, $Li^+ CH(SiMe_3)_2$, in hexane to give the homoleptic alkyl complexes $An[CH(SiMe_3)_2]_3$ (An = Np, 7; An = Pu, 8). The homoleptic silylamide, aryl oxide, and alkyl complexes are the first to be reported for transuranic elements. 17 refs.

51311 (LBL–26455, pp. 56-57) **Vibrational and electronic spectroscopy of pyridine and benzene adsorbed on the Rh(111) crystal surface.** Mate, C.M.; Somorjai, G.A.; Tom, H.W.K.; Zhu, X.D.; Shen, Y.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The interaction of aromatic molecules with metal surfaces has recently been the subject of several investigations. Much of this interest is derived from the importance of aromatic molecules, such as fuels, chemicals, and lubricants, that are produced and utilized by technologies where surface phenomena play a dominant role. For example, aromatic compounds are desirable products of heterogeneous catalytic reactions in the refining of crude oil into high-octane fuels. In lubrication, aromatic compounds are frequently used as functional groups in extreme-pressure additives, even though their role is not understood. Therefore, a molecular-scale understanding of how aromatic molecules interact with metal surfaces should be of considerable importance. They report the vibrational and electronic spectra for pyridine and benzene adsorbed on the Rh(111) crystal surface obtained by high-resolution electron-energy-loss spectroscopy (HREELS). Low-energy electron diffraction (LEED), thermal-desorption spectroscopy (TDS), and optical SHG have also been used to provide complementary information. Pyridine adsorption on Rh(111) was studied over the 77-450 K temperature range.

51312 (LBL–26455, pp. 74) **Studies of the metal/solution interface with x rays.** Ross, P.N. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

During the last two decades there have been great advances in the development of methods for the analysis of the structure of surfaces in ultrahigh vacuum (UHV), which has led to a detailed understanding of the chemistry of free surfaces. Further advances of comparable magnitude will be necessary to develop an equivalent level of understanding of structure at interfaces, particularly the technologically important cases of interfaces between condensed phases. In this work, the authors address the problem of structure determination at the metal/solution interface. Study of the metal/solution interface is relevant to technologies like metal corrosion electrochemical energy conversion (fuel cells), and storage devices (batteries), and the rapidly growing new technology of electrolytic epilayers for photovoltaics, magnetic recording, and electro-optic devices. The problem of structure determination at the interface between condensed phases is a difficult one. Most of the techniques developed for the study of solid surface in UHV cannot be applied to the interface between condensed phases, since they rely on the diffraction, scattering, or emission of electrons. The electrons scattered or emitted from the interface are too severely attenuated by

the condensed phases for external detection and analysis. New techniques must be developed that utilize more penetrating, higher-momentum photons like x rays, gamma rays, or neutrons. They are pursuing the use of x rays, and especially x-ray diffraction, for structure determination at the metal/solution interface.

51313 (LBL–26455, pp. 75) **Potential-dependent reconstruction of Au(111) and (100) surfaces in solution.** Van Hove, M.; Ross, P. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

GID experiments provided the first in situ evidence for the reconstruction of Au(111) in aqueous solution. The in-plane (2θ) scan clearly showed the appearance of superlattice reflections of periodicity $\sim a_0/20$, about the same as the superlattice periodicity of the ($\sqrt{3} \times 22$) reconstruction observed in UHV. This reconstruction is observed at potentials cathodic to the potential of zero charge (PZC) and is postulated to arise from the localization of electron density in the surface layer when solvated cations contact the surface at negative bias (potentials cathodic to the PZC).

51314 (LBL–26455, pp. 75) **Work in progress.** Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The reconstruction of the Au(111) and (100) surfaces at potentials cathodic to the PZC into structures that appear to be related to the UHV reconstructions are being studied in detail using both x-ray reflectivity measurements and GID. The type of cation in the electrolyte, as well as the chemistry of the ion-metal interaction, is expected to play an important role in the reconstruction. Also of interest here are other metals whose clean low-index surfaces are not reconstructed in UHV but become reconstructed when alkali metals are placed on the surface, such as the (1 x x) reconstructions of Ag(110), Pd(110), and Cu(110) caused by K adsorption. Such reconstructions may also occur on these surfaces at potentials cathodic to their PZCs in potassium-containing electrolyte, depending on the effect of solvation on the alkali-metal/noble-metal interaction; i.e., reconstruction may occur only in electrolytes with weakly solvated cations like Cs.

51315 **American Chemical Society, Division of Organic Chemistry.** 168p. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Separate abstracts were prepared for 57 papers of this divisional meeting of the 199th ACS National Meeting.

51316 **American Chemical Society, Division of Inorganic Chemistry.** 229p. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Separate abstracts were prepared for 275 papers of this divisional meeting of the 199th ACS National Meeting.

51317 **Reinforcement of elastomers by the in-situ generation of filler particles.** Mark, J.E. (Univ. of Cincinnati, Dept. of Chemistry, Cincinnati, OH (US)); Schaeffer, D.W. pp. 51-56 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper discusses investigations into the development of novel methods for filling elastomeric networks. The techniques developed employ the *in-situ* generation of reinforcing fillers such as silica or a glassy polymer such as polystyrene either after, during, or before network formation. The reaction involves decomposition of organometallic compounds, using a variety of catalysts and precipitation conditions, or free-radical polymerization of a suitable monomer. The effectiveness of the technique is gauged by stress-strain measurements carried out on these elastomeric composites to yield values of the maximum extensibility, ultimate strength, and energy of rupture. Also of interest are calorimetric studies of the networks, to determine their crystallizability. Information on the filler particles themselves is obtained from density determinations, electron microscopy, and scattering measurements.

51318 **Theoretical nonlinear polarizabilities of Pn compounds.** Risser, S.M. (Pacific Northwest Laboratory, Richland, WA (USA)); Ferris, K.F. pp. 155, Paper INOR 531 of American Chemical Society, Division of Inorganic Chemistry. American Chemical Society, Washington, DC (US) (1990). pp. 229 DOE Contract AC06-76RL01830. (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Large optical nonlinearities have been observed both experimentally and theoretically for conjugated organic molecules. These large nonlinearities have been attributed primarily to the delocalized π electrons, giving reason to believe that similarly large nonlinearities exist for conjugated inorganic molecules and polymers. We have calculated the nonlinear polarizabilities for a series of inorganic molecules, using CNDO eigen energies and wave functions, and second and third order perturbation theory. We will report the hyperpolarizabilities for a series of cyclic and linear phosphonitrilic molecules.

51319 **Optical properties of inorganic polymers.** Ferris, K.F. (Pacific Northwest Laboratory, Richland, WA (USA)); Risser, S.M. pp. 155, Paper INOR 532 of American Chemical Society, Division of Inorganic Chemistry. American Chemical Society, Washington, DC (US) (1990). pp. 229 (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Inorganic polymers are characterized by both in-plane π' and out-of-plane π bonding interactions, contrary to those of the conventional organic materials where π effects alone dominate the optical properties. For the phosphonitrilic systems, the involvement of the in-plane π' bonding network is regulated by the ligand electronegativity attached to the phosphorus, and results in the optical transition energies being higher than their organic based analogues. In this paper, we will present results relating electronic structure properties such as dipole moments to their non-linear optical properties for a series of model phosphazene compounds.

51320 **Uranium(IV) alkoxide complexes.** Van Der Sluys, W.G. (Los Alamos National Laboratory, NM (USA)); Morris, D.E.; Smith, W.H.; Sattelberger, A.P.; Streib, W.E.; Huffman, J.C. pp. 160, Paper INOR 549 of American Chemical Society, Division of Inorganic Chemistry. American Chemical Society, Washington, DC (US) (1990). pp. 229 (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

The reaction of $[(Me_3Si)_2N]_2UN(SiMe_3)SiMe_2CH_2$ (1) with $\geq$4.5 equivalents of tert-butanol in refluxing toluene provides green crystalline $U_2(OBu^t)_8(HOBu^t)$ (2), which has been characterized by ^1H NMR, IR, and X-ray crystallography. 2 reacts with $KOBu^t$ or KH in toluene to give $KU_2(OBu^t)_9$ (3). Both 2 and 3 react with O_2-free water in toluene to provide the trinuclear cluster $U_3O(OBu^t)_{10}$ (4) $\geq$50% yield. The redox properties of 2-4 will be discussed. We will also describe the synthesis and characterization of a dinuclear uranium(IV) siloxide complex, $U_2(OSiMe_2Bu^t)_8$ (5), whose solid-state structure differs significantly from those of 2 and 3.

51321 **Photophysical characterization of neutral monomeric bis(alkoxide) and bis(amide) uranyl complexes.** Smith, D.C. (Los Alamos National Laboratory, NM (USA)); Burns, C.J.; Sattelberger, A.P. pp. 160, Paper INOR 550 of American Chemical Society, Division of Inorganic Chemistry. American Chemical Society, Washington, DC (US) (1990). pp. 229 (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Treatment of $UO_2Cl_2(Ph_3PO)_2$ with two equivalents of potassium tert-butoxide or sodium bis(trimethylsilyl)amide in tetrahydrofuran yields $UO_2(O\text{-}t\text{-}Bu)_2(Ph_3PO)_2$ (1) and $UO_2(N(SiMe_3)_2)_2(Ph_3OP)_2$ (2), respectively. Solid samples of these complexes are highly luminescent. At 77 K, the luminescence of 1 is highly structured; for 2, the band remains broad and only weakly structured. We will report the room- and low-temperature absorption, emission, and excitation spectra of 1 and 2. Isotopic substitution of the UO_2 chromophore has enabled us to assign the dominant vibrational progression observed in the emission spectrum.

51322 **Infrared reflection spectroscopy: Probing structure-reactivity relationships at liquid-solid interfaces.** Stole, S. (Ames Lab. US DOE, Ames, IA (US)); Wu, C.; Popenoe, D.; Porter, M. pp. 155 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

There are a variety of in situ techniques currently available for the molecular level characterization of the electrode surface. These techniques, which include, infrared reflection spectroscopy, Raman spectroscopy, and optical second harmonic generation, are capable of providing detailed information relative surface concentration of the interfacial structure. This paper examines the structure and reactivity of a variety of monomolecular assemblies at electrode surfaces via in situ infrared microscopy. Emphasis is placed on probing the effects of immobilization on the reactivity of the acidic functional groups of organosulfur compounds [$HS(CH_2)_NCOOH$, n = 10-16] self-assembled at gold. The influence of solvent polarity on the structure of these assemblies and those of n-alkyl thiols is examined. Correlations between structure and substrate roughness are described.

51323 **Exciplex formation and electron transfer in polychromophoric systems.** Yang, N.C.C. (Chicago Univ., IL (USA). Dept. of Chemistry); Minsek, D.W.; Johnson, D.G.; Wasielewski, M.R. pp. 111-116 of Photochemical energy conversion. Norris, J.R.; Meisel, D. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). pp. 364 DOE Contract W-31-109-ENG-38. (CONF-880767–: 7. international conference on photochemical conversion and storage of solar energy, Evanston, IL (USA), 31 Jul - 5 aug 1988).

This paper discusses the rates of excited anthracene decay and intramolecular exciplex formation from biochromophoric molecules containing an anthryl group and an amine donor which vary with the length of the chain link, the nature of the amine donor and the viscosity of the medium. According to the authors, the results indicate that the intramolecular exciplex formation may proceed via more than one pathway. Experimental results suggest that electron transfer from the amino donor to the excited anthryl group may play a role in the exciplex formation in viscous alkanes.

51324 **Structure and properties of resorcinol-formaldehyde gels.** Letts, S.A. (Univ. of California, Lawrence Livermore National Lab., CA (US)); Buckley, S.R.; Kong, F.M.; Lindsay, E.F.; Sattler, M.L. pp. 275-280 of Macromolecular liquids: Materials Research Society symposium proceedings. Volume 177. Safinya, C.R.; Safran, S.A.; Pincus, P.A. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 427 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

The condensation polymerization of resorcinol and formaldehyde catalized by sodium carbonate produces a sol that aggregates to form a gel. Using viscometry the effect of temperature and catalyst concentration on the sol-gel transition has been investigated. At a solids concentration of 3%, gelatin occurred in 1500 minutes. The rate of increase in viscosity was a function of both catalyst concentration and temperature. The structure of the gels was studied by freeze-fracture TEM. In the sol phase the RF solutions contain particles of 5 to 20 nm diameter. After gelation the particles form a crosslinked network with a pore structure of 100 nm.

51325 **Formation of metal colloids in inverse micelles and microemulsions.** Wilcoxon, J.P. (Organizations 1153 and 1833, Sandia National Lab., Albuquerque, NM (US)); Williamson, R.L. pp. 269-274 of Macromolecular liquids: Materials Research Society symposium proceedings. Volume 177. Safinya, C.R.; Safran, S.A.; Pincus, P.A. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 427 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

Gold colloidal suspension are produced from both inverse micelle solutions and microemulsions through both chemical and photolytic reduction of the appropriate salt. A variety of surfactant/solvent combinations yield varying results with respect to metalloid growth kinetics and stability as revealed through dynamic light scattering, small-angle x-ray and neutron scattering, and transmission electron microscopy.

51326 **Morphological consequences of catalytic hydrogenation of polymers in the bulk.** Gilliom, L.R. (Sandia National Lab., NM (US)); Schaefer, D.W.; Mark, J.E. pp. 275-284 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper describes studies on the morphology of samples of trans-1,4-polybutadiene and syn-1,2-polybutadiene which have been partially deuterated in the bulk. The development of a peak in the SANS data for the 1,2-polybutadiene suggests the formation of small domains upon deuteration. Possible explanations for this observation, including chemical and physical heterogeneity, are evaluated. Results of SAXS and thermal measurements are also considered.

51327 **Synthetic control of molecular structure in organic aerogels.** Pekala, R.W. (Lawrence Livermore National Lab., CA (US)). pp. 285-292 of Polymer based molecular composites: Materials Research Society symposium proceedings. Volume 171. Schaefer, D.W.; Mark, J.E. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 431 (CONF-891119–: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989).

This paper discusses organic aerogels that have been formed from the aqueous, sol-gel polymerization of resorcinol with formaldehyde. These materials are transparent and have continuous porosity with cell/pore sizes of less than 1000Å. Their microstructure is composed of interconnected colloidal-like particles with diameters of 30–200 Å. The author reports that the particle size, cell size, surface area, and density of the aerogels are predominantly controlled by the catalyst concentration used in gel preparation.

51328 **Measurement of mercury vapor adsorption on gold using a micromirror, optical fiber sensor.** Butler, M.A. (Sandia National Labs., Albuquerque, NM (USA)); Ricco, A.J. pp. 971 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract AC04-76DP00789. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The amalgamation of Hg with Au is a well-known process in the mining industry, but the details of this interaction do no appear to be understood. The authors report some results of the initial interaction of Hg with Au, as well as the subsequent initiation of the amalgamation process using reflectivity changes of Au micromirrors on the end of an optical fiber. The micromirrors are optically thin (50-500 angstroms) Au films deposited by evaporation on the ends of multimode optical fibers (125 microns in diameter). Exposure of these films at room temperature to Hg partial pressures well below saturation results in an increase in films reflectivity, a consequence of the increased optical thickness of the Au film caused by the Hg adsorption.

51329 **EPR characterization of Ti^{3+} ions at the metal-support interface in Pt/TiO_2 catalysts.** Bonneviot, L. (Universite P. et M. Curie (France)); Haller, G.L. *Journal of Catalysis (USA)*, 113(1): 96-105 (Sep 1988). DOE Contract AC02-81ER10829.

Titania-supported Pt catalysts prepared by cation exchange 0.44 and 1.0 wt% loading and reduced at low, medium, and high temperatures (513, 573, and 773 K, respectively) were studied by EPR. The spectra of four different Ti^{3+} ions have been resolved at 17 K; only two of these species are surface Ti^{3+} which are sensitive to CO or H_2 adsorption. One of these surface species, characterized by an axial g tensor at $g_\perp = 1.969$ and $g_\parallel = 1.936$, is specific of the presence of platinum since it does not exist in reduce TiO_2. Its signal undergoes a temperature-dependent broadening effect which is mostly removed at 17 K; this is related to its proximity to a platinum particle allowing an efficient relaxation mechanism through the conduction electrons of the metal. This ion can be titrated reversibly by hydrogen and irreversibly by carbon monoxide. Its intensity relative to other Ti^{3+} ions increases when the reduction temperature increases from 373 to 573 K. This trend is probably maintained for the reduction at 773 K, but no accurate

conclusions can be drawn since the EPR signal undergoes a strong decrease in intensity and line broadening due to spin pairing and spin-spin relaxation mechanisms. These two effects are related to the increase of Ti^{3+} concentration in the vicinity of platinum, the metal promoting the reduction of the support. This species, located at the metal-support interface, may either account for the TiO_x fragments of the support which migrate on the metal particles in the SMSI state or be a precursor of these fragments. 35 refs.

51330 Coupled catalytic oscillators: CO oxidation over polycrystalline Pt. Tsia, P.K. (Univ. of California, La Jolla (USA)); Maple, M.B.; Herz, R.K. *Journal of Catalysis (USA)*, 113(2): 453-465 (Oct 1988).

The authors have observed unusual oscillation in the rate of CO oxidation over a polycrystalline Pt wire loop. In contrast to simple oscillations between states of low and high reactivity, the unusual oscillations occurred between low, intermediate, and high values of the reaction rate. Experiments were performed at atmospheric pressure in a gas flow reactor over a range of gas temperatures and CO partial pressures. The reaction rate was measured using a thermocouple spotwelded to the loop. For a given CO partial pressure, oscillations occurred over a range of gas temperatures. Oscillations were simple at high gas temperatures and became complex as the temperature was lowered. When the authors monitored two thermocouples on opposite sides of the loop, they found that oscillations on the two sides occurred in phase, but differed in details of shape and amplitude. When they cut the loop and separated the halves, the complex oscillations at lower gas temperatures disappeared, and oscillations on the half-loops occurred with different frequencies. Results obtained by varying the separation showed that coupling between the half-loops occurred primarily through the gas phase. When the loop was spotwelded back together, oscillations became resynchronized, and complex waveforms reappeared at lower gas temperatures. To their knowledge, this is the first experimental demonstration that coupling chemical oscillators can increase the parameter space over which oscillatory instabilities occur. 47 refs.

51331 Stereochemical consequences of halogen atom substitution. 1. Rotational conformer effects in gaseous diastereomeric 2,3-dihalobutanes. Sharma, R.B. (Univ. of Nebraska, Lincoln (USA)); Meyer, R.J.; Rack, E.P.; Ferrieri, R.A.; Wolf, A.P. *Journal of Physical Chemistry (USA)*, 94(6): 2316-2320 (22 Mar 1990).

The stereochemical consequences of translationally excited ^{38}Cl-for-X (X = F, Cl) substitution in (2S,3R)-meso- and (2S,3S)-dl-difluorobutane, (2S,3R)-dl- and (2S,3S)-dl-chlorofluorobutane, and (2S,3R)-meso- and (2S,3S)-dl-dichlorobutane were studied in the gas phase. Although retention of configuration was determined to be the dominant substitution pathway, substantial inversion product yields were observed in all cases. A comparison of these yields revealed that the (S,R) configuration within each set always gave a smaller yield of the inverted product than the (S,S) configuration.

51332 Inner-shell excitation of gas-phase and polymer thin-film 3-alkylthiophenes by electron energy loss and X-ray photoabsorption spectroscopy. Hitchcock, A.P. (McMaster Univ., Hamilton, Ontario (Canada)); Tourillon, G.; Garrett, R.; Williams, G.P.; Mahatsekake, C.; Andrieu, C. *Journal of Physical Chemistry (USA)*, 94(6): 2327-2333 (22 Mar 1990).

Oscillator strengths for C 1s and S2p excitation have been derived from gas-phase electron energy loss spectra of a series of 3-alkyl-substituted thiophenes. The C 1s oscillator strength spectra are compared to the C 1s near-edge X-ray absorption fine structure (NEXAFS) spectra of electropolymerized thin films of the same materials. In the gas-phase-monomer spectra the width and peak intensity of the C 1s $\rightarrow \pi^*$ excitation are essentially unchanged on alkylation.

51333 Dissociation dynamics: Measurements of decay fractions of metastable ammonia cluster ions. Wei, S. (The Pennsylvania State University, Department of Chemistry, University Park, Pennsylvania 16802 (USA)); Tzeng, W.B.; Castleman, A.W. Jr. *Journal of Chemical Physics (USA)*, 93(4): 2506-2512 (15 Aug 1990). DOE Contract FG02-88ER60648.

The decay fractions of metastable ammonia cluster ions which undergo unimolecular (evaporative) dissociation in a time window of 1–40 μs were measured by using a reflection time-of-flight mass spectrometer. Corrections concerning instrumental artifacts and ion trajectory of parents and daughters are made to imporve the precision of the measurements. The data are used to derive the Gspann parameter and heat capacity of clusters as described in evaporative ensemble model of metastable dissociation. Using the dissociation fractions measured in the present studies, in conjunction with kinetic energy release values previously measured in our laboratory, we apply Klots' evaporative ensemble model to obtain binding energies of ammonia cluster ions $(NH_3)_nH^+$, $4 \leq n \leq 17$. The deduced binding energy values are found to be in very good agreement with both thermochemical data and Engelking's modified statistical theory.

51334 Rotational partition functions for symmetric-top molecules. McDowell, R.S. (University of California, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)). *Journal of Chemical Physics (USA)*, 93(4): 2801-2811 (15 Aug 1990).

A simple, accurate closed-form expression for the rotational partition functions of symmetric-top molecules is derived, which includes the effects of nuclear-spin statistics (significant at very low temperatures), quartic and sextic centrifugal distortion terms (moderate and high temperatures), and inversion (all temperatures): $Q_r \cong \sigma^*(\pi m)^{\frac{1}{2}} \exp[\beta(4-m)/12]\beta^{-3/2}[1+\beta^2(1-m)^2/90+\cdots](1+\delta)\ (1+\rho_1\beta^{-1}+\rho_2\beta^{-2}+\rho_3\beta^{-3})$, where $\beta \equiv hcB/kT$, $m \equiv B/A$ for prolate tops or B/C for oblate tops ($A>B>C$ are the rotational constants), and $\sigma^* \equiv \Pi_i(2I_i+1)/\sigma$, where I_i is the spin of nucleus i and σ is the classical symmetry number. For $C_{3v}XY_3$ and WXY_3 molecules, the low-temperature nuclear-spin correction is $\delta \approx 2(2I_Y+1)^{-2} \exp[\pi^2 m(\beta m-6)/54\beta]$; similar expressions are given for other molecular models. The ρ's are functions of the centrifugal distortion constants D_J, D_{JK}, D_K, H_J, etc. If inversion doubling occurs, with a splitting ΔG in the ground vibrational state, this expression for Q_r is to be multiplied by $(1-\beta\Delta G/2B+\cdots)$.

51335 Br^*+CO_2 revisited: An interrogation of *E–V* energy transfer with time-resolved diode laser spectroscopy. Sedlacek, A.J. (Brookhaven National Laboratory, Department of Chemistry, Upton, NY (USA)); Weston, R.E. Jr.; Flynn, G.W. *Journal of Chemical Physics (USA)*, 93(4): 2812-2818 (15 Aug 1990). DOE Contract FG02-88ER13937.

High resolution (0.0003 cm^{-1}) time-resolved diode laser absorption spectroscopy has been used to reinvestigate the electronic–vibrational energy transfer from spin–orbit excited bromine, $Br(^2P_{1/2})$, to carbon dioxide. The experiments are carried out by generating Br^* atoms with pulsed 193 nm laser photolysis of CF_3Br and monitoring the subsequent energy transfer by following directly the temporal evolution of selected vibrational states of CO_2 (10^01, 02^01, 02^21 and 00^01). By comparing the temporal profile of the 10^01 state with that predicted by various kinetic models it has been established that quenching of Br^* by CO_2 occurs via the nearly resonant 10^01 state. The *E–V* rate measured in the present study, $(4.8\pm0.6)\times10^5$ $Torr^{-1}$ s^{-1}, agrees well with that reported previously using infrared fluorescence probes. It has also been determined that the efficiency of this energy transfer is 0.87 ± 0.15; that is, on average, 87% of the spin–orbit excited energy of the Br^* atoms will show up as CO_2 vibrational energy. The rate constant for the vibrational relaxation of the 10^01 state is found to be $(4.1\pm0.5)\times10^6$ $Torr^{-1}$ s^{-1}, also in good agreement with previous low resolution fluorescence measurements.

51336 Diffusion-controlled ion recombination in multipair clusters in low-permittivity solvents. Green, N.J.B. (Physical Chemistry Laboratory, Oxford (England)); Pimblott, S.M. *Journal of Physical Chemistry (USA)*, 94(7): 2922-2926 (5 Apr 1990).

A master equation formalism is presented which describes the evolution of the number of reactive particles in a multipair spur. This technique is particularly appropriate for modeling ion combination in low-permittivity solvents. For the simple case where all the cation-anion distances are identically distributed, the equations can be solved analytically in terms of the geminate survival probability.

An analytic solution for the free-ion yield from an ensemble of isolated clusters also follows. Solutions are compared with simulation results and with other models of the same process.

51337 Coadsorption and reaction of water and potassium on Ag(111). Blass, P.M. (Univ. of Texas, Austin (USA)); Zhou, X.L.; White, J.M. *Journal of Physical Chemistry (USA),* 94(7): 3054-3062 (5 Apr 1990).

KOH formation on Ag(111) has been studied with UPS, XPS, TPD, AES, isotopic exchange, and work function measurements. O(1s) XPS indicates that coadsorbed potassium and water react very slowly at 100 K at submonolayer and multilayer K precoverages. D_2 and D_2O TPD spectra of K + D_2O layers provide evidence for KOD formation and decomposition temperatures, as well as the desorption temperatures of water that hydrates KOD. UPS, XPS, and TPD indicate that KOD formation is complete at 300 K. In TPD of H_2O on KOD, D-for-H exchange is observed. KOH layers are altered by exposure to a 3-keV electron beam.

51338 Solid-state voltammetry and self-diffusion dynamics of a linear monotagged redox polymer: ω-ferrocenecarboxamido-α-methoxypoly(ethylene oxide). Pinkerton, M.J. (Univ. of North Carolina, Chapel Hill (USA)); Le Mest, Y.; Zhang, H.; Watanabe, M.; Murray, R.W. *Journal of the American Chemical Society (USA),* 112(10): 3730-3736 (9 May 1990). DOE Contract FG05-87ER13675.

The synthesized title labeled polymer, Fc-MePEG, MW = 2,590, analytically characterized as free of unlabeled PEO and of ferrocene monomer, dissolves $LiClO_4$ electrolyte and in dry undiluted form is both a polymer electrolyte and an electroactive phase. The microelectrode solid-state voltammetrically measured, center-of-mass self-diffusion coefficient for Fc-MePEG in its polymer let, 1.3×10^{-8} cm^2/s at 62°C, is 3.4 times smaller than that for ferrocene monomer dissolved in unlabeled (MW = 2,380) Me_2PEG. Electron hopping is estimated to contribute less than 10% to the diffusion rates of Fc-MePEG and of monomer dissolved at 40-50 mM concentrations in unlabeled Me_2PEG. At room temperature, where Fc-MePEG and Me_2PEG are waxy solids, $D_{Fc-MePEG}$ is 3.9×10^{-12} cm^2/s, 12 times smaller than that of monomer ferrocene, in Me_2PEG, and which corresponds to a diffusion pathlength of ca. 110-200 nm during the electrochemical experiment. Dissolved in CH_3CN or CH_2Cl_2, Fe-MePEG diffuses 8-10 times more slowly than ferrocene monomer which is consistent with transport as a random coiled sphere.

51339 The effect of pressure on the surface plasmon absorption spectra of colloidal gold and silver particles. Coffer, J.L. (Univ. of Illinois, Urbana (USA)); Shapley, J.R.; Drickamer, H.G. *Journal of the American Chemical Society (USA),* 112(10): 3736-3742 (9 May 1990). DOE Contract AC02-76ER01198.

The first measurements of the effect of pressure on the peak position (ω_{sp}) and line width (fwhm) of the surface plasmon absorption in several Au and Ag hydrosols have been recorded up to 10 kbar. Red shifts of the plasmon peak with increasing pressure are observed for relatively large metal particles prepared by the citrate procedure (Au, $\bar{d}$ = 265 Å; Ag, $\bar{d}$ = 230 Å). The shift for silver is over twice that of gold (-420 cm^{-1} vs $-$ 200 cm^{-1}). These red shifts are interpreted in terms of pressure-induced volume changes within the context of a free-electron model. In contrast, particles prepared by the Faraday method (Au, $\bar{d}$ = 54 Å; Ag, $\bar{d}$ = 60 Å) show initial blue shifts with pressure, with the magnitude again larger for silver. Upon aging (as well as upon heating in the case of Au), the Au and Ag Faraday sols exhibit an increase in their average particle size and degree of aggregation. Correspondingly, the pressure response of their plasmon absorption approaches that of the citrate sols.

51340 Molecular hydrogen complexes of the transition metals. 7. Kinetics and thermodynamics of the interconversion between dihydride and dihydrogen forms of $W(CO)_3(PR_3)_2H_2$ where R = isopropyl and cyclopentyl. Khalsa, G.R.K. (Los Alamos National Lab., NM (USA)); Kubas, G.J.; Unkefer, C.J.; Van Der Sluys, L.S.; Kubat-Martin, K.A. *Journal of the American Chemical Society (USA),* 112(10): 3855-3860 (9 May 1990).

Kinetic and thermodynamic parameters have been obtained for the equilibrium system $H_2W(CO)_3(PR_3)_2 \rightleftharpoons W(CO)_3(PR_3)_2(\eta^2\text{-}H_2)$. The systems studied include a newly synthesized complex where R = cyclopentyl. ^{31}P NMR spin saturation transfer studies over a temperature range of 288-310 K afford values of $\Delta H^{\ddagger} = 10.1 \pm 1.8$ kcal/mol, $\Delta S^{\ddagger} = -19.9 \pm 6.0$ eu, and $\Delta G^{\ddagger} = 16.0 \pm 0.2$ kcal/mol (298 K) for the dihydrogen to dihydride exchange process where R = isopropyl. Exchange between nonequivalent hydrides in the seven-coordinate dihydride complex corresponds to $\Delta G^{\ddagger} \approx 11$ kcal/mol (253 K) derived from NMR coalescence data. $^1H(^{31}P)$ NMR equilibrium studies for the formation of the dihydrogen complex from the dihydride complex over the temperature range 265-309 K produce the following: $\Delta H^{\circ} = -1.2 \pm 0.6$ kcal/mol, $\Delta S^{\circ} = -1.2 \pm 2.1$ eu, and $\Delta G^{\circ} = -0.80 \pm 0.12$ kcal/mol (298 K).

51341 Synthesis of molybdenum imido alkylidene complexes and some reactions involving acyclic olefins. Schrock, R.R. (Massachusetts Institute of Technology, Cambridge (USA)); Murdzek, J.S.; Bazan, G.C.; Robbins, J.; DiMare, M.; O'Regan, M. *Journal of the American Chemical Society (USA),* 112(10): 3875-3886 (9 May 1990). DOE Contract FG05-86ER75292.

The reaction between Mo(C-t-Bu)(dme)Cl_3 (dme = 1,2-dimethoxyethane) and $Me_3SiNHAr$ (Ar = 2,6-diisopropylphenyl) yields Mo(C-t-Bu)(NHAr)Cl_2(dme) (1), which upon treatment with a catalytic amount of NEt_3 is transformed into Mo(CH-t-Bu)(NAr)Cl_2(dme) (2). Complexes of the type Mo(CH-t-Bu)(NAr)$(OR)_2$ (OR = $OCMe(CF_3)_2$, $OCMe_2(CF_3)$, O-t-Bu, or OAr) have been prepared from 2. Complexes of the type Mo(C-t-Bu)(NHAr)$(OR)_2$ (OR = $OCMe(CF_3)_2$ or OAr) have been prepared from 1, but they cannot be transformed into Mo(CH-t-Bu)(NAr)$(OR)_2$ complexes. A precursor to imido alkylidene complexes that is related to 2 has been prepared by the sequence $MoO_2 \rightarrow MoO_2Cl_2 \rightarrow Mo(NAr)_2Cl_2 \rightarrow Mo(NAr)_2(CH_2R')_2 \rightarrow$ Mo(CHR')(NAr)$(OTf)_2$(dme) (R' = t-Bu or CMe_2Ph; OTf = OSO_2CF_3). Mo(CH-t-Bu)(NAr)$(OTf)_2$(dme) crystallizes in the space group $P\bar{1}$ with a = 17.543 Å, b = 19.008 Å, c = 9.711 Å, α = 91.91°, β = 99.30°, γ = 87.27°, Z = 4, M_r = 729.60, V = 3,191.1 $Å^3$, ρ(calcd) = 1.518 g cm^{-3}.

51342 Bond strengths of ethylene and acetylene. Ervin, K.M. (Univ. of Colorado, Boulder (USA)); Gronert, S.; Barlow, S.E.; Gilles, M.K.; Harrison, A.G.; Bierbaum, V.M.; DePuy, C.H.; Lineberger, W.C.; Ellison, G.B. *Journal of the American Chemical Society (USA),* 112(15): 5750-5759 (18 Jul 1990). DOE Contract FG02-87ER13695.

Negative ion photoelectron spectroscopy and gas-phase proton transfer kinetics were employed to determine the CH bond dissociation energies of acetylene, ethylene, and vinyl radical: D_0(HCC-H) = 131.3 ± 0.7 kcal mol^{-1}, $D_0(CH_2CH\text{-}H)$ = 109.7 ± 0.8 kcal mol^{-1}, and $D_0(CH_2C\text{-}H)$ = 81.0 ± 3.5 kcal mol^{-1}. The strengths of each of the other CH and CC bonds in acetylene and ethylene and their fragments were derived. The energy required to isomerize acetylene to vinylidene was also determined: $HC{\equiv}CH \rightarrow H_2C{=}C$: $\Delta H_{isom,0} = 47.4 \pm 4.0$ kcal mol^{-1}. As part of this study, proton transfer kinetics in a flowing afterglow/selected-ion flow tube apparatus were used to refine the acidities of ethylene, acetylene, and vinyl.

51343 Ion-molecule reaction chemistry of ionic transition-metal carbonyl clusters fragments. 1. Ligand-exchange reactions of $Cr_2(CO)_y^+$ ions. Sellers-Hahn, L. (Texas A and M Univ., College Station (USA)); Russell, D.H. *Journal of the American Chemical Society (USA),* 112(16): 5953-5959 (1 Aug 1990).

The ligand-exchange ion-molecule reaction chemistry of $Cr_2(CO)_y^+$ ionic transition metal cluster fragments has been investigated by using a two-section ion cell Fourier transform ion cyclotron resonance mass spectrometer. Simple ligand-exchange reactions involving ligand (L) addition followed by metal-ligand (M—CO) bond cleavage (i.e., an associative ligand-exchange mechanism) as well as ligand exchange involving metal-metal cleavage (i.e. addition of L to $Cr_2(CO)_y^+$ followed by metal-metal bond cleavage) are observed. The branching ratios for reactions involving metal-metal bond cleavage increase as the metal-to-ligand ratio decreases. In addition, the ratio for simple ligand exchange to metal-metal bond cleavage is strongly dependent upon the nature of the reacting ligand (L). These data combined with collision-induced dissociation data for $Cr_2(CO)_y^+$ ionic cluster fragments suggest that the Cr-Cr

bond strength decreases as y is increased; i.e., the Cr—Cr bond order is strongly dependent upon the ligand environment.

51344 **Morphology control in electrochemically grown conducting polymer films. 1. Precoating the metal substrate with an organic monolayer.** Rubinstein, I. (Los Alamos National Lab., NM (USA)); Rishpon, J.; Sabatani, E.; Redondo, A.; Gottesfeld, S. *Journal of the American Chemical Society (USA)*, 112(16): 6135-6136 (1 Aug 1990).

The authors report in this communication on a significant increase in the density of an electrochemically grown conducting polymer film obtained by preadsorbing a self-assembling monolayer onto the surface of the electrode substrate. Further work in progress addresses questions of the preservation of the effect of this surface treatment in thicker CP films and the nature of the resulting changes in mechanical, electronic, and electrochemical properties of the CP film.

4004 Electrochemistry

Refer also to citation(s) 50930, 50931, 50932, 50933, 51034, 51122, 51213, 51260, 51316

51345 (AD-A-223649/5/XAB) **Radioactive-labeling study of sulfate/bisulfate adsorption on smooth gold electrodes.** Zelenay, P.; Rice-Jackson, L.M.; Wieckowski, A. Illinois Univ., Urbana, IL (USA). Dept. of Chemistry. 1990. 14p. Grant AFOSR-89-0368. Source: NTIS, PC A03/MF A01.

Pub. in Jnl. Electroanal. Chem., Vol. 283, 389-401(1990).

Adsorption of sulfate/bisulfate anions was studied on a smooth gold electrode by the use of the radioactive labeling method. Adsorption is reversible with respect to the bulk concentration of adsorbate and the electrode potential. The chemical component in adsorption is weak, as assessed from an almost linear relationship between surface concentration and the electrode potential. This indicates that the surface attachment occurs predominantly through electrostatic interactions between the surface and the ions, which were concluded to be bisulfate anions. Processing the radiochemical information using the Bennes adsorption isotherm yields basic thermodynamic magnitudes, such as standard Gibbs energy of adsorption and the interaction energy. Their analysis reveals that in the studied bulk concentration range a strong interionic repulsion limits the uptake of anions to ca. 30% of a maximum coverage.

51346 (AD-A-223653/7/XAB) **Adsorption of pyridine on polycrystalline gold electrode studied by radioactive-labeling method.** Zelenay, P.; Rice-Jackson, L.M.; Wieckowski, A. Illinois Univ., Urbana, IL (USA). Dept. of Chemistry. 1990. 7p. Grant AFOSR-89-0368. Source: NTIS, PC A02/MF A01.

Pub. in Langmuir, Vol. 6, 974-979(1990).

Adsorption of pyridine on smooth polycrystalline gold was studied by the use of the radioactive-labeling method and electrochemistry. The adsorption is reversible and, in the range of the structural uniformity of the adsorbate, characterized by the standard Gibbs energy of adsorption of 30 KiloJoules per mole. Weak repulsive interactions between vertically adsorbed pyridine molecules were found. At low bulk concentrations of the adsorbate, a horizontally oriented pyridine occupies the surface and rearranges to the vertical form with the increase in the electrode potential. The contrasting cases of pyridine adsorption on gold from acidic and neutral solution and differences encountered in bonding of pyridine by polycrystalline gold and platinum are discussed.

51347 (ORNL/FTR-3755) **[The latest developments of the physical aspects of electrochemistry]: Foreign trip report, August 31–September 9, 1990.** Liu, S.H. Oak Ridge National Lab., TN (USA). 24 Sep 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000383. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The author was one of 26 invited lecturers to discuss the latest developments of the physical aspects of electrochemistry. He interacted extensively with other lecturers and many participants from developing countries. He also visited with the Director of the Italian Synchrotron Radiation Source now under construction in Trieste, Italy.

51348 **Excited state absorption spectroscopy and spectroelectrochemistry of a binuclear and a mononuclear Ru(II) complex containing the ligand 2,3-bis(2-pyridyl)pyrazine.** Berger, R.M. (Univ. of Notre Dame, IN (USA)). pp. 144, Paper INOR 496 of American Chemical Society, Division of Inorganic Chemistry. American Chemical Society, Washington, DC (US) (1990). pp. 229 (CONF-900402--: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Excited state absorption spectra of the complexes $[(bpy)_2Ru(dpp)Ru(bpy)_2]^{4+}$ and $[Ru(bpy)_2(dpp)]^{2+}$ (bpy = 2,2′-bipyridine, dpp = 2,3-bis-(2′-pyridyl)pyrazine) have been obtained. The excited state spectra of both complexes exhibit bands in the near UV region characteristic of a reduced polypyridyl ligand. In the visible region, however, the spectra of the two complexes exhibit significant differences. Spectroelectrochemistry has been used to characterize the reduced forms of the complexes.

51349 **Application of the hanging meniscus rotating disk electrode method to O_2 reduction of platinum in H_3PO_4.** Kroen, C.F. (Center for Electrochemical Sciences and Engineering, Dept. of Materials Science, Univ. of Virginia, Charlottesville, VA (US)); Stoner, G.E.; Taylor, S.R. pp. 740-741 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107--: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Electrolyte leakage commonly occurs at the interface between the electrode and the insulating mantle when standard rotating disk electrode configurations are employed at temperatures in excess of 100°C. Alternate RDE configuration have been employed at temperatures up to 150°C, but involve extensive amounts of accurate machining and difficulties with mounting. The hanging meniscus rotating disk electrode (HMRDE) method has been shown to obey the Levich equation for the oxidation of ferri-ferrocyanide at a gold electrode with sodium sulfate as a supporting electrolyte. Since an insulating mantle is not required, the HMRDE method potentially provides a relatively simple electrode configuration for conducting elevated temperature RDE experiments. This investigation analyzes the applicability of the HMRDE method for studying the oxygen reduction reaction (ORR) on platinum in phosphoric acid.

51350 **A study of ferrocene diffusion dynamics in network poly(ethylene oxide) polymer electrolyte by solid-state voltammetry.** Watanabe, M. (Univ. of North Carolina, Chapel Hill (USA)); Longmire, M.L.; Murray, R.W. *Journal of Physical Chemistry (USA)*, 94(6): 2614-2619 (22 Mar 1990).

The diffusion rates of five ferrocene derivatives dissolved in an amorphous, cross-linked poly(ethylene oxide) (PEO) polymer electrolyte are measured by an electrochemical technique which detects the rate of their transport to an oxidizing microdisk electrode. The diffusion coefficients in dilute ferrocene/polymer solutions at 65°C vary from 3×10^{-7} to 2×10^{-8} cm^2 s^{-1} depending on the size of the ferrocene derivative. The diffusion coefficients decrease with increasing ferrocene concentration, increasing $LiClO_4$ electrolyte concentration, and decreasing temperature; values approaching 10^{-10} cm^2 s^{-1} are encountered at room temperature.

4005 Photochemistry

Refer also to citation(s) 50548, 51263, 51264, 51315, 51600

51351 (LBL–26455, pp. 49) **Far-infrared spectroscopy.** Richards, P.L. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Improvements in infrared technology are making possible increases in the sensitivity of many types of infrared and millimeter wave measurements. In this project, improved types of infrared sources, spectrometers, and detectors are being developed. Also, improved infrared techniques are being used to do experiments in areas of fundamental and applied infrared physics where their impact is expected to be large. Infrared experiments in progress include: measurements of the far-infrared absorptivity of the new high-T_c superconductors, measurements of the infrared emission

spectra of molecules chemically adsorbed on metal surfaces, measurements of the infrared spectra of one-dimensional conductors, and measurements of the heat capacity of monolayers of adsorbates on metal films. Developments in infrared technology include: development of thin-film high-T_c superconducting bolometers for detecting x-ray, infrared, and microwave radiation; development of superconducting thin-film quasiparticle detectors and mixers for near-millimeter wavelengths that approach quantum-limited sensitivity; and development of a new source for broadly tuned far-infrared spectroscopy based on harmonic generation from microwave oscillators.

51352 **Laser spectroscopic and quantum chemical studies of the lowest excited states of formic acid.** Ioannoni, F. (Brock Univ., St. Catharines, Ontario (Canada)); Moule, D.C.; Clouthier, D.J. *Journal of Physical Chemistry (USA)*, 94(6): 2290-2294 (22 Mar 1990). DOE Contract FG05-86ER13544.

A fluorescence excitation spectrum of formic acid monomer (HCOOH) has been recorded in the 268-257-nm region and has been attributed to an $n \rightarrow \pi^*$ electron promotion in the anti conformer. The $S_0 \leftarrow S_1$ electronic origins of the HCOOH/HCOOD/DCOOH/DCOOD isotopomers were assigned to weak bands observed at 37,431.5/37,461.5/37,445.5/37,479.3 cm^{-1}. Four vibrational modes, ν_3(C=O), ν_7(O-C=O), ν_8(C-H_{ald}), and ν_9(O-H_{hyd}), were observed in the spectrum.

51353 **Photodissociation of RNCS and RSCN (R=H, CH_3, C_2H_5) : Evidence for an excited state isomerization and energy deposition in the NCS product.** Northrup, F.J. (Department of Chemistry, Brookhaven National Laboratory, Upton, New York 11973 (USA)); Sears, T.J. *Journal of Chemical Physics (USA)*, 93(4): 2337-2345 (15 Aug 1990). DOE Contract AC02-76CH00016.

The 248 and 193 nm photodissociation of the series of molecules RNCS and RSCN (R=H, CH_3, C_2H_5) has been investigated. Laser-induced fluorescence of the radical NCS was used to probe the energy deposition in the R+NCS channel of this dissociation, however excitation to many vibrational states of NCS caused spectral congestion which prohibited direct measurement of populations of individual levels. A single-photon dissociation channel leading to RS and CN was observed for both isomers of all of the precursor molecules. While this was expected for the thiocyanate species, no direct channel to these products is available for the isothiocyanates. This observation is discussed in terms of an excited state isomerization of these molecules. Measured ratios of CN to NCS production for all compounds provide additional support for this mechanism and suggest a significant barrier to the process. Comparison of nascent laser-induced fluorescence (LIF) spectra of NCS with spectra obtained following different amounts of collisional relaxation suggests that all three vibrational modes were equally excited with a vibrational temperature of roughly 4500 K. The rotational temperature was estimated to be less than 1000 K. A spin–orbit population inversion was observed for all vibrational levels with approximately 75% of the population in the upper spin–orbit component of the vibrationless and low lying bending excited levels. No simple model is found to explain the photodissociation dynamics or the isomerization.

51354 **Photodissociation of RNCS and RSCN (R=H, CH_3, C_2H_5) at 248 and 193 nm: CN product energy distributions.** Northrup, F.J. (Department of Chemistry, Brookhaven National Laboratory, Upton, New York 11973 (USA)); Sears, T.J. *Journal of Chemical Physics (USA)*, 93(4): 2346-2356 (15 Aug 1990).

Photodissociation of the molecules RNCS and RSCN (R=H, CH_3, and C_2H_5) was investigated at 248 and 193 nm and the internal energy distributions in the CN resulting from the RS+CN fragmentation channel were probed by laser induced fluorescence. These CN distributions were identical for formation from the isomer pairs in agreement with an excited state isomerization postulated earlier. At 248 nm, all precursors lead to nearly thermal CN rotational distributions with rotational temperatures of approximately 1100 K in v=0 and 800 K in v=1. The vibrational distributions could not be characterized by the same temperatures. At 193 nm, contributions from two apparently different dissociation channels were observed. The CN rotational populations showed a narrow, strongly peaked distribution lying on a broad, approximately statistical distribution. For HNCS, this peak occurs near N=10 suggesting dissociation from an excited state with a linear NCS skeleton. For the alkyl precursors, the peak occurs at very high rotational quantum number (N=70) indicating an excited state with a bent NCS framework. Vibrational distributions with population out to v=6 were observed. In all cases, the apparent statistical part of the rotational distribution and the vibrational distributions can be described by a prior function derived assuming that the internal modes of the alkyl substituent are not involved in any energy redistribution during the dissociation.

51355 **Two-pulse coherent control of electronic states in the photodissociation of IBr: Theory and proposed experiment.** Levy, I. (Department of Chemical Physics, The Weizmann Institute of Science, Rehovot (Israel)); Shapiro, M.; Brumer, P. *Journal of Chemical Physics (USA)*, 93(4): 2493-2498 (15 Aug 1990). DOE Contract AC03-76SF00098.

It is shown how the principles of coherent control can be applied to a *pulsed* experiment aimed at controlling curve-crossing processes. A realistic computational study (incorporating the ground, *A*, *B*, and *Y* electronic states of IBr) of control of atomic states produced in the photodissociation of IBr is presented. The suggested scheme, which consists of applying an excitation pulse followed by a dissociation pulse, is theoretically shown to yield essentially *total* control over the Br*/Br atomic branching ratio. It is shown that the only external parameters that need to be varied are the central frequency of the excitation pulse and the time delay between the two pulses. A brief description of a proposed experiment is provided.

51356 **Electron spin resonance and electron spin echo modulation spectroscopic studies of the photoionization of phenothiazine derivatives in alkyl sulfate and alkyltrimethylammonium bromide micellar solutions.** Baglioni, P. (Univ. of Houston, TX (USA)); Hu, Ming; Kevan, L. *Journal of Physical Chemistry (USA)*, 94(6): 2586-2590 (22 Mar 1990).

Electron spin echo modulation and electron spin resonance of photoionized ω-phenothiazin-9-ylalkanesulfonate with alkyl + C_3H_7, C_6H_{13}, and $C_{12}H_{25}$ (PC_nS), 9-alkylphenothiazinesulfonate with alkyl = CH_3 and $C_{12}H_{25}$ (C_nPS), and methylphenothiazine have been studied as a function of the surfactant alkyl chain length of sodium alkyl sulfate and alkytrimethylammonium bromide micellar solutions in D_2O, with alkyl = decyl, dodecyl and tetradecyl. Deuterium modulation effects from x-doxylstearic acid interactions with water deuteriums indicate that only the decyl surfactants form micelles with significant water penetration at the micellar interface.

51357 **Excited-state dynamics of fluorene/substituted-benzene van der Waals complexes in supersonic jets: Dependence of exciplex formation on the relative energies of the lowest excited singlet states of component molecules.** Saigusa, Hiroyuki (Wayne State Univ., Detroit, MI (USA)); Lim, E.C. *Journal of Physical Chemistry (USA)*, 94(6): 2631-2637 (22 Mar 1990).

The fluorescence excitation and dispersed fluorescence spectra of the van der Waals complexes of fluorene with durene, 1,2,4,5-tetrafluorobenzene, and 1,2,4,5-tetrachlorobenzene have been studied in supersonic jets. In each system, the excitation spectra reveal long progressions in low-frequency models which can be assigned to the intermolecular vibrations between the constituent molecules.

51358 **Cooperative reactivity in photogenerated radical ion pairs: Photofragmentation of amino ketones.** Bergmark, W.R. (Univ. of Rochester, NY (USA)); Whitten, D.G. *Journal of the American Chemical Society (USA)*, 112(10): 4042-4043 (9 May 1990). DOE Contract FG02-86ER13504.

A number of instances of fragmentation (or cleavage) have recently been noted for certain electron donors when activated by photoinduced single electron transfer (SET) reactions. Herein the authors report a novel reaction in which scission of a strong carbon-carbon bond in an unexcited donor can be brought about via quenching of an excited acceptor. In this case, the aar seem to function as a nucleophile is a displacement within the contact ion pair; the net reaction involves a chemically clean and yet unprecedented ketone to amide interconversion.

51359 Photochemistry of $(\eta^5\text{-}C_5H_5)Rh(CO)_2$ in phosphine solutions: Evidence for an associative photosubstitution mechanism. Drolet, D.P. (State Univ. of New York, Binghamton (USA)); Lees, A.J. *Journal of the American Chemical Society (USA)*, 112(15): 5878-5879 (18 Jul 1990). DOE Contract FG02-89ER14039.

Over the past few years there has been much interest in the photochemistry of $(\eta^5\text{-}C_5R_5)ML_2$ and $(\eta^5\text{-}C_5R_5)ML(H)_2$ (M = Rh, Ir; R = H, CH_3; L = CO, PR_3 olefin) complexes leading to intermolecular activation of hydrocarbon C-H bonds. Recently, theoretical models of methane C-H bond activation have arisen based on this premise, i.e., that a coordinatively unsaturated 16-electron $(\eta^5\text{-}C_5R_5)ML$ complex is the key reactive intermediate. The authors present here a study of the solution photochemistry of $(\eta^5\text{-}C_5H_5)Rh(CO)_2$ in the presence of excess scavenging PPh_3 ligand; the results show unequivocally that this photoreaction proceeds via an associative mechanism.

4006 Radiation Chemistry

Refer also to citation(s) 50649, 51600, 52267

51360 (CONF-8804141–, pp. 259-268) **Track core effects in heavy ion radiolysis.** Katz, R. (Univ. of Nebraska, Lincoln (USA)); Huang, Guo Rong. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena*. 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Though there is no evident track core in the radial dose distribution about the path of an energetic heavy ion, whether by measurement or calculation, the term has been given an air of reality by assigning to it a dimension, typically the Bohr adiabatic limit, showing the core as a discrete step in a graph of the radial dose distribution, and by describing the response of various detectors as having a penumbra contribution and a track core contribution. Since track theory does not recognize the existence of a core in energy deposition, these so-called track core effects must have another explanation. In track theory they are attributed to detector characteristics rather than to the shape of the dose distribution. Thus insensitive detectors which are only activated when several delta rays pass through a target are preferentially activated close to the ion's path while sensitive detectors activated by single electrons can be activated at all distances to which delta rays penetrate. The authors here analyze some recent data from radiation chemistry, namely that of LaVerne et al. on the production of HO_2• radicals in water, and of H_2 in benzene, by energetic heavy ions, and attributed by these authors to track core effects, on the assumption that these are 2 or more hit processes. 7 refs., 3 figs.

51361 (INT–194/I, pp. 132) **Kinetics of radiation decomposition of aqueous solutions of dyes and detergents as model systems for sewages of textile industry.** Perkowski, J. (Politechnika Lodzka, Lodz (Poland). Inst. Techniki Radiacynej); Ledakowicz, S.; Nowicki, L. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). In *Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane*. 132p. Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Published in summary form only. DETERGENTS/radiolysis; DYES/radiolysis; AQUEOUS SOLUTIONS; CHEMICAL REACTION KINETICS; DETERGENTS; RADIOLYSIS; DYES; INDUSTRY; TEXTILES

51362 (INT–194/I, pp. 121-131) **Polyester resin of small shrinkage.** Szalinska, H. (Politechnika Lodzka, Lodz (Poland). Inst. Techniki Radiacynej); Pietrzak, M. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). In *Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane*. 132p. Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The hardening of polyester resin by gamma radiation is described. The process parameters as well as effects are presented. (A.S.).

51363 Electronic decay of core hole excited states in molecular oxygen. Lapiano-Smith, D. (Department of Chemistry, State University of New York, Stony Brook, New York 11794-3400 (USA)); Lee, K.; Ma, C.; Wu, K.T.; Hanson, D.M. *Journal of Chemical Physics (USA)*, 93(4): 2169-2175 (15 Aug 1990).

Electron energy spectra characterizing the relaxation of molecular oxygen from different core hole excited states are reported. By using monochromatic synchrotron radiation, spectra are obtained with excitation at the π^* and σ^* resonances and at various energies above the ionization threshold. The spectra obtained with excitation above threshold are very similar and result from Auger decay. The spectra obtained at the σ^* resonance result from spectator autoionization, and those for the π^* resonance result from both spectator and participator autoionization. The σ^* resonance is broadened by spectral congestion, and the autoionization spectra indicate the presence of three components. Configurations and states produced by the electronic decay are identified, and a correlation between spectator screening and term values is documented.

51364 Bromine atom complexes with bromoalkanes. Their formation in the pulse radiolysis of di-, tri-, and tetrabromomethane and their reactivity with organic reductants. Shoute, L.C.T. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Neta, P. *Journal of Physical Chemistry (USA)*, 94(6): 2447-2453 (22 Mar 1990).

Bromine atoms were produced in the pulse radiolysis of neat dibromomethane (DBM) and bromoform and of cyclohexane solutions containing DBM, bromoform, carbon tetrabromide, or ethyl bromide. The Br atoms form complexes with dimethyl sulfoxide (λ_{max} 425 nm), with aromatic compounds, and with oxygen-containing compounds. In the absence of other complexing agents, since Br atoms do not abstract H from the solvents rapidly, they form complexes with their parent bromo compounds. The absorption maxima of these complexes are at 365 nm for $C_2H_5Br{\cdot}Br$, 390 nm for $CH_2Br_2{\cdot}Br$, 425 nm for $CHBr_3{\cdot}Br$, and 480 nm for $CBr_4{\cdot}Br$.

51365 Radiolytic generation of radical cations in xenon matrices. Tetramethylcyclopropane radical cation and its transformations. Qin, X.Z. (Argonne National Laboratory, IL (USA)); Trifunac, A.D. *Journal of Physical Chemistry (USA)*, 94(7): 3188-3192 (5 Apr 1990). DOE Contract W-31-109-ENG-38.

Radiolytic generation of radical cations in xenon matrices containing electron scavengers is illustrated by studying the 1,1,2,2-tetramethylcyclopropane radical cation. Dilute and concentrated solutions of tetramethylcyclopropane in xenon without electron scavengers and neat tetramethylcyclopropane yielded neutral radicals upon γ-irradiation. Speculation on the mechanisms of radical formation is presented. The radical species observed in the γ-irradiation of neat tetramethylcyclopropane appears to be identical with the paramagnetic species observed in $CF_2ClCFCl_2$ above 120 K, suggesting that a neutral radical rather than the ring-opened distonic radical cation is observed in the $CF_2ClCFCl_2$ matrix.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 51310, 51974, 52167

51366 (DOE/EV/10596–T2) **Development of Bromine-77 from the LAMPF facility: [Annual report].** Mettler, F.A. Jr. New Mexico Univ., Albuquerque, NM (USA). Dept. of Radiology. [1982]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AS04-81EV10596. Order Number DE91000113. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of the work is to conduct the necessary studies required to evaluate the efficacy, potential benefit and role of bromine-77 labelled steroids in the detection and evaluation of treatment for hormone-dependent tumors. The synthetic goals of the project are to prepose estradiol derivatives which are labelled

with bromine-77 at specific positions in the steroid nucleus. In addition, animal studies imaging studies, and cooperative studies are being conducted. (KJD)

51367 (DOE/EV/10596–T3) **Development of Bromine-77 from the LAMPF facility: Progress report.** Mettler, F.A.; Hylarides, M. New Mexico Univ., Albuquerque, NM (USA). School of Medicine. 3 Dec 1982. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AS04-81EV10596. Order Number DE91000114. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of the work is to conduct the necessary studies required to evaluate the efficacy, potential benefit and role of bromine-77 labelled steroids in the detection and evaluation of treatment for hormone-dependent tumors. The synthetic goals of 1982-3 included the synthesis estradiol derivatives which were radiohalogenated in the A- or C-ring with bromine-77 or bromine-82. Estradiol derivatives in which the radiohalogen was incorporated into the C-ring were prepared and purified with high specific activity. Biodistribution studies of the resultant compounds will be performed on rats in the near future. Various synthetic approaches toward estradiol which is radiohalogenated in the 1-position are discussed.

51368 (DOE/EV/10596–T4) **[Development of radionuclides from the LAMPF facility]: Annual report.** Mettler, F.A.; Hylarides, M.D. New Mexico Univ., Albuquerque, NM (USA). School of Medicine. 6 Nov 1984. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AS04-81EV10596. Order Number DE91000115. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The research objectives and goals of 1983–84 to date include further investigation of 1-halogenated and B-/C-ring halogenated and radio halogenated estradiol derivatives for potential use as receptor-binding radiopharmaceuticals. Our group has devised synthetic routes to 1-bromo, 1-chloro- and 1-fluoroestradiol via electrophilic halogenation of the aromatic A-ring. Work is presently underway to prepare the 1-iodo derivative using a similar methodology. The 11 β-methoxy, 17 α-ethynyl and 11 β-methoxy-17 α-ethynyl derivatives are of synthetic interest if the in vitro binding affinities of the parent compounds are favorable. The B- and C-ring 'vinyl halides' which were proposed in the current contract could not be prepared using the hydrazone intermediates described. Presently, other methods which show promise are being investigated. Stable B-ring brominated derivatives of estradiol have been prepared by our group. Their in vitro properties are currently under investigation. 15 refs.

51369 (DOE/EV/10596–T5) **[Development of Br-77 from LAMPF Facility].** New Mexico Univ., Albuquerque, NM (USA). School of Medicine. [1985]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AS04-81EV10596. Order Number DE91000116. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The research goals of 1984–1985 included continued studies of the 1-halogenated estradiol derivatives and preparation of B- and C- ring vinyl halides of estradiol. The radiohalogenated analogs of these target compounds are proposed to be useful as receptor-binding radiopharmaceuticals in breast cancer therapy. To date, all 1-halogenated derivatives have been prepared and studied. Their 17 α-ethynyl derivatives have also been prepared. In vitro receptor-binding studies with estrogen receptors show definite trends with respect to type of halogen attached versus observed receptor-binding affinity. These results were further substantiated using x-ray crystallographic methods. The proposed B- and C- ring vinyl halides have not been successfully synthesized; however, work toward these target compounds is still underway. Other related compounds of current interest include the B-, C-, and D- ring substituted estradiol derivatives. Much of the synthetic work leaking to these compounds has been accomplished and in vitro studies will be performed soon. 10 refs.

51370 (DOE/EV/10596–T6) **[Development of Bromine-77 from the LAMPF facility]: [Final report].** New Mexico Univ., Albuquerque, NM (USA). Dept. of Radiology. [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AS04-81EV10596. Order Number DE91000117. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of the work was to conduct the necessary studies required to evaluate the efficacy, potential benefit and role of bromine-77 labeled steroids in the detection and evaluation of treatment for hormone-dependent tumors. This report presents progress on the following tasks: An initial investigation concentrating on the radiobromination at carbon-6 or carbon-7 in selected simple steroids utilizing the nuclides, bromine-82 and bromine-77, analytical spectroscopy of radiolabeled compounds, and investigating the biodistribution, toxicology and tumor affinity of labeled agents.

51371 (JAERI-M–90-094) **Fabrication of neptunium, plutonium, americium and curium metals for fuel research: Review report.** Suzuki, Yasufumi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Handa, Muneo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 35p. (In Japanese). Order Number DE91713027. Source: NTIS (US Sales Only), PC A03/MF A01.

The techniques for the fabrication of actinide metals; neptunium, americium and curium called as minor actinides, and plutonium, are surveied in a viewpoint of the preparation of starting materials for fuel property measurements. In this report, the processes of the conversion to metals, purification et al. are reviewed. The concept related to the apparatus design is also proposed and the considerable subjects are discussed. (author).

51372 (MINTEK-M–305/D) **The beneficiation of nickel-copper ore from Uitkomst.** Overbeek, P.W. Council for Mineral Technology, Randburg (South Africa). Ore-dressing Div. 24 Apr 1987. 52p. Source: Available from Mintek, Private Bag X3015, Randburg, 2125, South Africa.

Ore samples from the Uitkomst deposit were treated by beneficiation techniques to establish a flowsheet for the economic recovery of Ni and Cu. These techniques included pre-concentration by sorting, heavy-medium separation, magnetic separation, and gravity concentration through spiralling at a coarse size. Flotation tests were carried out to confirm, and in an attempt to improve on, results from a previous investigation, and bacterial leaching was conducted on ore and concentrates from heavy-medium separation and flotation tests. None of the pre-concentration techniques tested gave acceptable metal recoveries in a low mass of concentrate, and there was no improvement in liberation when the ore was reduced in size. Heavy-medium separation was successful in rejecting the acid-consuming constituents of the ore that would be deleterious to bacterial leaching. A modified flotation procedure was developed that compared favourably with the initial procedure, but the recoveries of metal were still approximately 20 per cent below those obtained initially. Mineralogical examination showed that the ores were highly oxidized, which accounts for the lower recoveries by flotation. The ore samples as received do not appear to be representative of the orebody. The results of the bacterial-leaching tests showed promise, and this procedure should be considered as a means of treating concentrate rather than the whole ore. The removal of acid-consuming constituents by heavy-medium separation will give high recoveries of metal and, although the mass rejected as waste is not high (28 per cent), the resulting concentrate is amenable to bacterial leaching. The non-representativeness of the ore samples and the high degree of oxidation place some constraints on the interpretation of the test results, and it is possible that fresh ore representative of the orebody will give more meaningful and positive results. 39 ills., 50 tabs., 2 refs.

51373 (UCRL-LR–103220-Vol.2) **Multiple Group Analysis (MGA): A gamma-ray spectrum analysis code for determining plutonium isotopic abundances: Volume 2, A guide to using MGA.** Gunnink, R.; Ruhter, W.D. Lawrence Livermore National Lab., CA (USA). 1 Sep 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000065. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

MGA calculates relative isotopic abundances of plutonium and other actinides in a sample. The code performs its analysis using data from a gamma-ray spectrum of the sample taken with a germanium detector. This volume describes the structure of the program and the procedures used for measuring samples and analyzing the spectra. It is assumed that the user is familiar with standard practices and equipment used in gamma-ray spectrometry.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 51425, 51426

51374 (AD-A-223321/1/XAB) **Fuel structure and pressure effects on the formation of soot particles in diffusion flames. Annual report, 15 January 1989-15 January 1990.** Santoro, R.J. Pennsylvania State Univ., University Park, PA (USA). Dept. of Mechanical Engineering. 1 May 1990. 67p. Grant AFOSR-87-0145. Source: NTIS, PC A04/MF A01.

Studies emphasizing the effects of fuel concentration and operating pressure on the formation of soot particles have been conducted in a series of laminar diffusion flames. These experiments have shown that fuel concentration has a measurable effect on the amount of soot formed in the flame. However, a simple, constant proportionality between the fuel concentration and soot volume fraction has not been found to apply for the range of flow conditions studied. This observation is believed to be a result of flame residence time and diffusion effects which mitigate the consequences of reduced initial fuel concentration. Comparisons with simple laminar diffusion flame models are currently being used to investigate the relationship between initial fuel concentration and local flame concentration fields. Similar studies of soot formation in laminar diffusion flames as a function of operating pressure have also been completed for ethene, ethane and propene fuel species.

51375 (LA-UR-90-3159) **Detoxification of hazardous waste streams using microwave-assisted fluid-bed oxidation.** Varma, R. (Argonne National Lab., IL (USA)); Nandi, S.P.; Katz, J.D. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900466-87: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE91000228. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Microwave-assisted oxidation of trichloroethane (TCE) performed at 500-580°C has been found to be significantly more efficient than conventional oxidation methods. Experiments were conducted using a 6 kilowatt, 2.45 gigohertz power supply and a 6 inch bed of silicon carbide granules in a 1 inch diameter quartz reactor tube which in turn was placed in a microwave cavity. After heating the reactor to a given temperature a TCE-air stream was passed through the silicon carbide bed. TCE was almost completely detoxified (98-99%) in a single pass through the silicon carbide bed at 500-580°C. The oxidation products are HCl, CO_2 and CO. By comparison the corresponding single-pass detoxification using conventional thermal methods results in only partial conversion. The principal products being dichloroethylene ($C_2H_2Cl_2$) and HCl. 5 refs., 1 tab.

51376 (UCRL-JC-104065) **A chemical kinetic modeling study of chlorinated hydrocarbon combustion.** Pitz, W.J.; Westbrook, C.K. Lawrence Livermore National Lab., CA (USA). 5 Sep 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9010197-1: American flame research committee 1990 fall international symposium, San Francisco, CA (USA), 8-10 Oct 1990). Order Number DE91000261. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The combustion of chloroethane is modeled as a stirred reactor so that we can study critical emission characteristics of the reactor as a function of residence time. We examine important operating conditions such as pressure, temperature, and equivalence ratio and their influence on destructive efficiency of chloroethane. The model uses a detailed chemical kinetic mechanism that we have developed previously for C_3 hydrocarbons. We have added to this mechanism the chemical kinetic mechanism for C_2 chlorinated hydrocarbons developed by Senkan and coworkers. In the modeling calculations, sensitivity coefficients are determined to find which reaction-rate constants have the largest effect on destructive efficiency. 24 refs., 6 figs., 1 tab.

51377 **Flame spread in an opposed turbulent flow.** Zhou, L. (Dept. of Mechanical Engineering, Univ. of California, Berkeley, CA (US)); Fernandez-Pello, A.C.; Cheng, R. *Combustion and Flame (USA)*, 81(1): 40-49 (Jul 1990).

An experimental study is presented of the influence of turbulence on the spread of flames over the surface of a solid combustible in a gas flow opposing the direction of flame propagation. The flow velocity and its turbulent intensity are varied to observe their effects on the flame spread rate over thick PMMA and thin filter paper sheets. Also observed is their effect on the conditions for flame extinction. The results show that for thick PMMA sheets the spread rate first increases and then decreases with increasing turbulent intensity. The presence of a maximum appears to be the result of the flow transition from laminar to turbulent that influences the heat transfer process from flame to fuel. It is shown that the decrease of the spread rate with the turbulence intensity is primarily due to the convective cooling of the region near the flame front in conjunction with other less important mechanisms related to flame and surface radiation.

51378 **A model for soot formation in a laminar diffusion flame.** Kennedy, I.M. (Dept. of Mechanical Engineering, Univ. of California, Davis, CA (US)); Kollmann, W.; Chen, J.Y. *Combustion and Flame (USA)*, 81(1): 73-85 (Jul 1990).

A simple model has been developed for the prediction of soot volume fractions in a laminar diffusion flame. Measurements and computations of a counterflow flame have been used to evaluate the correlation between soot surface growth rates and the mixture fraction or fuel atom mass fraction. An average particle number density was used to permit the determination of the aerosol surface area. Equations for the momentum, mixture fraction, and soot volume fraction were solved numerically for an axisymmetric laminar diffusion flame. Good agreement was obtained with the measurements for two different experimental conditions.

51379 **Elementary reactions and primary dissociation processes relevant to combustion.** Lee, Y.T. (Lawrence Berkeley Lab., CA (USA)). *American Chemical Society, Division of Environmental Chemistry, Preprints (USA)*, 30(1): 164 (1990). (CONF-900402-: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

In a series of crossed molecular beams studies of reactions of oxygen atoms and unsaturated hydrocarbons, it has become clear that even for relatively small systems, the intersystem crossing in the reaction intermediate plays a very important role. The recent experimental results on allene and ethylene will be discussed in some detail. The second subject which will be discussed in this lecture is the concerted dissociation processes of some cyclic hydrocarbons eliminating stable molecules as products. The dissociation of tetralin and cyclohexadiene will be shown as examples.

51380 **Nitrous oxide formation and destruction in lean, premixed combustion.** Martin, R.J. (Lawrence Berkeley Lab., CA (USA). Applied Science Div.); Brown, N.J. *Combustion and Flame (USA)*, 80(3): 238-255 (Jun 1990). DOE Contract AC03-76SF00098.

Concentration profiles of N_2O, NO, and N_2 from atmospheric pressure, flat-flame burner experiments are presented. Axial profiles of species and temperature are described for CH_4-air and H_2-O_2-Ar flames doped with either NH_3, NO, or N_2O. Species concentrations were determined by microprobe sampling and direct analysis by gas chromatography or chemiluminescence analysis, for flames ranging in temperature from 1300 to 2000 K. Burner surface temperatures were also estimated for these flames, using heat transfer analysis and an optical method. Nitrogen-atom balances were achieved in each of the H_2-O_2-Ar flames to within experimental error and better than 6%. Axial profiles of N_2O were similar for all flames. At sampling locations nearest to the burner (0.5-1.0 mm), N_2O concentrations were highest. Concentrations decreased monotonically in the downstream direction, with N_2O destruction essentially complete in the postflame region (height greater than 3 mm) for all flames except the one at the lowest temperature (1300 K).

51381 **Relation between group combustion and drop array studies.** Ryan, W. (Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering); Annamalai, K.; Caton, J. *Combustion and Flame (USA)*, 80(3): 313-321 (Jun 1990).

Spray combustion modeling requires a knowledge of the strength of the mass and heat sources for each drop in the spray. Since

sprays involve a large number of drops, interactive transport processes must be accounted for in estimating the source strengths of the drops. Earlier approaches (called array studies) considered a finite number of drops (2 to 9), and accounted for the three dimensional variation of temperature and species mass fraction profiles in order to determine an evaporation/combustion correction factor. This correction factor is defined as the ratio of the average strength of each drop in the array to the strength of the drop if it is kept in an isolated environment. The current approach utilizes group combustion theory which involves a large number of drops, assumes top hat profiles in the interstitial space between the drops, and accounts for their variation in the radical direction. The correction factor is again determined. This paper reports the results of the current group combustion approach and compares these results with those from array studies when the group combustion approach is extended to an array consisting of as few as 2 to 9 drops.

51382 **Effects of two-phase flow in a model for nitramine deflagration.** Li, S.C. (California Univ., San Diego, La Jolla, CA (USA). Dept. of Applied Mechanics and Engineering Sciences); Williams, F.A.; Margolis, S.B. *Combustion and Flame (USA),* 80(3): 329-349 (Jun 1990).

Methods of asymptotic analysis are employed to extend an earlier model for the deflagration of nitramines to account for the presence of bubbles and droplets in a two-phase layer at the propellant surface during combustion. Two zones are identified in the two-phase region: one, at higher liquid volume fractions, maintains evaporative equilibrium, whereas the other, at lower liquid volume fractions, exhibits nonequilibrium vaporization. By introducing the most reasonable estimates for two-phase behavior of nitramines, the steady burning rates are found to be close to those obtained for models with a sharp liquid-gas interface. Good agreement with measured burning rates and pressure and temperature sensitivities are achieved through reasonable approximations concerning overall chemical-kinetic parameters.

51383 **CO formation in the thermal decomposition of CH_3ONO at high temperatures: Kinetic modeling of the CH_3O decomposition rate.** Choudhury, T.K. (Catholic Univ., of America, Washington, DC (USA)); He, Y.; Sanders, W.A.; Lin, M.C. *Journal of Physical Chemistry (USA),* 94(6): 2394-2398 (22 Mar 1990).

CH_3ONO was pyrolyzed in two different temperature regimes in order to determine the kinetics of the CH_3O decomposition reaction. A static reactor operating between 550 and 770 K was used for the first set of experiments, with analysis of products (CO, CH_2O, and CH_3OH) by FTIR absorption. In the second set of experiments, a shock tube operating in the range 1,000-1,600 K was employed and the CO product was measured by resonance absorption of the output of a stabilized CW CO laser.

51384 **Rate constants for the reactions O + C_2H_2 and O + C_2D_2 → products, over the temperature range ~850-1,950 K, by the flash photolysis-shock tube technique. Determination of the branching ratio and a further theoretical analysis.** Michael, J.V. (Argonne National Laboratory, IL (USA)); Wagner, A.F. *Journal of Physical Chemistry (USA),* 94(6): 2453-2464 (22 Mar 1990). DOE Contract W-31-109-ENG-38.

Overall rate constants for the reactions O + C_2H_2 → products and O + C_2D_2 → products have been measured between ~850 and 1,950 K by the flash photolysis-shock tube (FP-ST) technique. The branching ratio of the process O + C_2H_2 → HCCO + H has been estimated by comparison experiments to the reaction O + H → OH + H, under identical conditions of first-order O-atom depletion, photolyte concentration, and flash energy.

51385 **Rate constants for the reaction D + D_2O → D_2 + OD by the flash photolysis-shock tube technique over the temperature range 1,285-2,261 K: Results for the back-reaction and a comparison to the protonated case.** Fisher, J.R. (Argonne National Laboratory, IL (USA)); Michael, J.V. *Journal of Physical Chemistry (USA),* 94(6): 2465-2471 (22 Mar 1990). DOE Contract W-31-109-ENG-38.

The absolute rate constant for the reaction of D atoms with deuterium oxide, D + D_2O → D_2 + OD, has been measured by using the flash photolysis-shock tube (FP-ST) technique. D atoms are monitored by atomic resonance absorption spectroscopy (ARAS) using a $Ly_{\alpha D}$ lamp. The experimental results have been compared with results from the analogous protonated case, and an isotope effect of unity is indicated within experimental error.

51386 **Flash photolysis-shock tube kinetic investigation of the reaction of $O(^3P)$ atoms with ammonia.** Sutherland, J.W. (Brookhaven National Laboratory, Upton, NY (USA)); Patterson, P.M.; Klemm, R.B. *Journal of Physical Chemistry (USA),* 94(6): 2471-2475 (22 Mar 1990). DOE Contract AC02-76CH00016.

The rate constant for the reaction of $O(^3P)$ with NH_3 was measured over the temperature range of 765-1,790 K by the flash photolysis-shock tube technique. The results, expressed in Arrhenius form, are $k_1(T) = (1.07 \pm 0.10) \times 10^{-10} \exp(-11{,}155 \pm 217/RT)$ (cm^3 $molecule^{-1}$ s^{-1}). When these results were combined with the directly determined, low-temperature data of Perry (448-841 K), $k_1(T)$ displayed distinct non-Arrhenius behavior over the extended temperature range of 448-1,790 K.

51387 **A high-temperature photochemical kinetics study of the O + HCl reaction from 350 to 1,480 K.** Mahmud, K. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Kim, Jongsung; Fontijn, A. *Journal of Physical Chemistry (USA),* 94(7): 2994-2998 (5 Apr 1990).

Rate coefficients for the O + HCl reaction have been measured by using two differently designed high-temperature photochemistry (HTP) reactors. Measurements were made under pseudo-first-order conditions, [O] ≪ [HCl], at temperatures from 350 to 1,480 K and pressures from 100 to 613 Torr. Ground-state O atoms were generated by flash photolysis of O_2 or CO_2 and monitored by time-resolved atomic resonance fluorescence with pulse counting. Combining the present data with published measurements in the 350-720 K range yields $k(T) = 5.6 \times 10^{-21} T^{2.87} \exp(-1{,}766\ K/T) cm^3$ $molecule^{-1}$ s^{-1} for the 350-1,480 K range with a 2σ confidence interval of 23%, which figure includes a liberal allowance for potential systematic errors.

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4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 50521, 50552, 50555, 50557, 50643, 50891, 51126, 51449, 51594, 51629, 51880, 52592, 52593, 52594, 52595, 52596, 52597, 52598, 52599, 52600

51388 (CONF-900809--4) **Efficiency and mass loading characteristics of a typical HEPA [High Efficiency Particulate Air] filter media material.** Novick, V.J. (Argonne National Lab., IL (USA)); Higgins, P.J.; Dierkschiede, B.; Abrahamson, C.; Richardson, W.B.; Monson, P.R.; Ellison, P.G. Argonne National Lab., IL (USA). [1990]. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 21. DOE/NRC nuclear air cleaning conference; San Diego, CA (USA); 13-16 Aug 1990. Order Number DE90017796. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The particle removal efficiency of the HEPA filter material used at the Savannah River Site was measured as a function of monodisperse particle diameter and two gas filtration velocities. The results indicate that the material meets or exceeds the minimum specified efficiency of 99.97% for all particle diameters at both normal and minimum operating flow conditions encountered at the Savannah River site. The pressure drop across the HEPA filter material used at the Savannah River site was measured as a function of particle mass loading for various aerosol size distributions.The pressure drop was found to increase linearly with the particle mass loaded onto the filters, as long as the particles were completely dry. The slope of the curve was found to be dependent on the particle diameter and velocity of the aerosol. The linear behavior between the initial pressure drop (clean filter) and the final pressure drop (loaded filter) implies that the filtration mechanism is dominated by the particle cake that rapidly forms on the front surface of the HEPA filter. This behavior is consistent with the high filtration efficiency of the material. 16 refs., 14 figs.

51389 (CONF-9005183–, pp. 103-110) **Characterization of three-dimensional elastic-plastic crack front fields.** Parks, D.M. (Massachusetts Institute of Technology, Cambridge (USA)). Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-85ER13331. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

A two-parameter framework for describing elastic-plastic crack front fields in contained yielding is outlined. The second crack front parameter, in addition to the J-integral, is the normalized T-stress, or second Williams coefficient. Novel computational procedures based on the simple line-spring model are developed for determining T. In conjunction with modified boundary layer studies of elastic-plastic crack fields, the T-stress calibrations provide highly accurate descriptions of 3D elastic-plastic surface crack front fields at loads up to ~ 80% of limit load. 16 refs., 5 figs.

51390 (CONF-9005183–, pp. 190-196) **Mono- and poly-circle theorems in solids and fluids.** Honein, T. (Stanford Univ., CA (USA)); Honein, E.; Herrmann, G. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The heterogenization procedure, recently developed by the authors, is briefly reviewed. It provides a powerful tool for the stress and flow analysis in regions containing inclusions with circular or straight boundaries. As a further novel application of this procedure, circularly layered inclusions are studied and the potential usefulness in design is pointed out, as well as other possible extensions. 6 refs., 2 figs.

51391 (CSCE–CE03156, pp. 671-688) **The impact of a free-fall submersible capsule onto the ocean surface.** Hinchey, M. (Memorial Univ. of Newfoundland, NF (Canada)); Goteti, R.; Sharp, J. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings.* 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

The Ocean Ranger and other oil rig disasters have shown that rig evacuation systems often do not work properly during severe storms. To avoid this problem a free-fall submersible capsule system is proposed. Upon release from the rig, the capsule would fall freely to the ocean surface. It would then sink into the ocean to a level where water motion is insignificant and thus avoid the violent air and water motions near the surface. There are many factors that have to be considered for a complete investigation of such a system. This paper is concerned mainly with its impact onto the ocean surface. Two sets of impact experiments were conducted. In the first, the decelerations experienced by a spherical capsule were measured. In the second, a video camera was used to examine the underwater trajectories of spherical, conical and cylindrical capsules. The data from the first set showed that the decelerations experienced by a capsule are well within human tolerance limits: typically, they are less that 5 g and their duration is about 0.25 seconds. The data also showed that the deceleration phenomenon is governed by Froude number scaling. The second set of experiments showed a rapid transition from Froude number to Reynolds number scaling. Typically, by the time a capsule is 2 to 4 characteristic dimensions below the water surface, it has reached a terminal speed and its motion is governed by a balance between weight and viscous drag only. This information is now being used in a control study of the underwater motion of a capsule. 13 refs., 18 figs.

51392 (JAERI-M–90-093) **Dynamics of biped locomotion robot: Equations of straight walking motion.** Takanishi, Atsuo (Waseda Univ., Tokyo (Japan)); Kato, Ichiro; Kume, Etsuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 54p. (In Japanese). Order Number DE91713026. Source: NTIS (US Sales Only), PC A04/MF A01.

The Human Acts Simulation Program, HASP in short, started in 1987 at JAERI. In the HASP, the motion of a human shaped robot is being simulated numerically. First, focusing on one of most fundamental human motions, biped locomotion has been simulated. The model of human biped locomotion in this study is based on the model of Prof. Vukobratovic, Yugoslavia. The steady walking has been simulated on flat floor and go up and down the stairs. However the gait is not only for these simple motions but also for complicated ones such as starting, stopping and turning motions. In order to simulate the motions of a human shaped robot, it is necessary to set up the equations of motions and their restrictions from the point of view of mechanical analysis of human motions. This paper shows equations of motion and their restrictions when the biped locomotion robot starts and stops walking. (author).

51393 (ORAU–89/C-140, pp. 37-77) **A task planner for simultaneous fulfillment of operational, geometric and uncertainty-reduction goals.** Hutchinson, S.A. (Purdue Univ., W. Lafayette, IN (USA)); Kak, A.C. Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

The goal in robot planning is to develop a planner which can create complete assembly plans given as input a high level description of assembly goals, geometric models of the components of the assembly, and a description of the capabilities of the work cell (including the robot and the sensory system). In this paper, the authors introduce SPAR, a planning system which reasons about high level operational goals, geometric goals and uncertainty-reduction goals in order to create assembly plans which consist of manipulations as well as sensory operations when appropriate. Operational planning is done using a nonlinear, constraint posting planner. Geometric planning is accomplished by constraining the execution of operations in the plan so that geometric goals are satisfied, or, if the geometric configuration of the world prevents this, by introducing new operations into the plan with the appropriate constraints. When the uncertainty in the world description exceeds that specified by the uncertainty-reduction goals, SPAR introduces either sensing operations or manipulations to reduce that uncertainty to acceptable levels. If SPAR cannot find a way to sufficiently reduce uncertainties, it does not abandon the plan. Instead, it augments the plan with sensing operations to be used to verify the execution of the action, and, when possible, posts possible error recovery plans, although at this point, the verification operations and recovery plans are predefined. 36 refs., 10 figs., 2 tabs.

51394 (ORAU–89/C-140, pp. 79-98) **Dynamic task allocation and execution monitoring in teams of cooperating humans and robots.** Harmon, S.Y. (Robot Intelligence International, San Diego, CA (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

Dynamic task allocation and execution monitoring are critical elements for the effectiveness of teams of cooperating humans and robots. Execution monitoring is necessary to identify when and where dynamic allocation is needed. Dynamic task allocation enables the resources of the team to be efficiently mapped onto the demands of the prevailing task regardless of its changing nature and uncertainties. The technology to realize dynamic task allocation comes from the areas of distributed problem solving, multiple coordinated robots, error recovery, scheduling and human-machine interactions. 56 refs.

51395 (SAND–89-2563) **Evaluation of commercially available lighting design software.** McConnell, D.G. Sandia National Labs., Albuquerque, NM (USA). Sep 1990. 22p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AC04-76DP00789. Order Number DE91000469. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report addresses the need for commercially available lighting design computer programs and evaluates several of these

programs. Sandia National Laboratories uses these programs to provide lighting designs for exterior closed-circuit television camera intrusion detection assessment for high-security perimeters.

51396 (SAND–90-0440) **The Robotic Edge Finishing Laboratory.** Loucks, C.S.; Selleck, C.B. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE91000475. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Robotic Edge Finishing Laboratory at Sandia National Laboratories is developing four areas of technology required for automated deburring, chamfering, and blending of machined edges: (1) the automatic programming of robot trajectories and deburring processes using information derived from a CAD database, (2) the use of machine vision for locating the workpiece coupled with force control to ensure proper tool contact, (3) robotic deburring, blending, and machining of precision chamfered edges, and (4) in-process automated inspection of the formed edge. The Laboratory, its components, integration, and results from edge finishing experiments to date are described here. Also included is a discussion of the issues regarding implementation of the technology in a production environment. 24 refs., 17 figs.

51397 (SAND–90-1510) **Mass definition, mass measurement and recommendations.** Braudaway, D.W. Sandia National Labs., Albuquerque, NM (USA). Sep 1990. 17p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE91000458. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Mass measurements may be greatly enhanced by an understanding of the operation of balances, the effects of buoyancy, practices encountered in weighing and the impacts and meanings of revelant mass standards. Beginning with the basic forces acting on weights, the equations brought to equality in balances are developed. These give explanation of the weighing process and an appreciation for some balance characteristics. The requirements of relevant mass standards are also reviewed. Recommendations are made for operation of practical mass calibration. An appendix is attached which gives computation examples using "apparent mass" and also gives a method for determining the density of mass artifacts or unknown materials. 2 tabs.

51398 (SAND–90-2320C) **Solid state radioluminescent sources: Mixed organic/inorganic hybrids.** Gill, J.T. (EG and G Mound Applied Technologies, Miamisburg, OH (USA)); Ellefson, R.E.; Smith, H.M.; Renschler, C.L.; Shepodd, T.J. Sandia National Labs., Albuquerque, NM (USA); EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789 ;AC04-88DP43495. (CONF-9009201–6: Radioluminescent technology conference, Annapolis, MD (USA), 25-26 Sep 1990). Order Number DE90017550. Source: NTIS, PC A02/MF A01 - OSTI.

This concept brings a condensed source of tritium into close proximity with an inorganic phosphor. That source may thus become the equivalent of many atmospheres of tritium gas pressure. If both phosphor and tritium source material are optically clear, then a lamp's brightness may be made to scale with optical path length. Proof of principle of this concept has been demonstrated and will be described. A theoretical treatment is presented for the results here and for results from aerogel experiments.

51399 (SAND–90-2400C) **Archimedes: A system that plans and executes mechanical assemblies.** Strip, D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004243–1: IEEE international conference on robotics and automation, Sacramento, CA (USA), 7-12 Apr 1990). Order Number DE91000036. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Archimedes is a prototype mechanical assembly system which generates and executes robot assembly programs from a CAD model input. The system addresses the unrealized potential for flexibility in robotic mechanical assembly applications by automating the programming task. Input is a solid model of the finished assembly. Parts relationships and geometric constraints are deduced from the solid model. A rule-based planner generates a "generic" assembly plan that satisfies the geometric constraints, as well as other constraints embodied in the rules. A retargetable plan compiler converts the generic plan into code specific to an application environment. Execution of the compiled plan in a workcell containing an Adept Two robot, a vision system, and other parts handling equipment will be shown on videotape.

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Refer also to citation(s) 50393, 50453, 51377, 51382, 51390, 51425, 51426

51400 (CONF-9005183–, pp. 1-8) **Sedimentation of particles through quiescent suspensions.** Abbott, J.R. (Massachusetts Institute of Technology, Cambridge (USA)); Brenner, H.; Graham, A.L.; Mondy, L.A. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Studies of falling-ball rheometry in concentrated suspensions, embodying a combination of analysis, experiment, and numerical simulation, are discussed. Experiments involve tracking small balls falling slowly through otherwise quiescent suspensions of neutrally buoyant particles. A theory has been developed relating the average ball velocity to the macroscopic suspension viscosity, and, for dilute suspensions, agreement is obtained with Einstein's sheared suspension viscosity. Detailed trajectories of the balls, obtained either with new experimental techniques or by numerical simulation, are statistically interpreted in terms of the mean settling velocity and the dispersion about that mean. The authors show that falling-ball rheometry, using small balls relative to the suspended particles, can be a means of measuring the macroscopic zero-shear viscosity without disturbing the original microstructure significantly: thereiore, falling-ball rheometry can be a powerful tool to study the effects of microstructure on the macroscopic properties of suspensions. 25 refs.

51401 (CONF-9005183–, pp. 9-18) **Particle dispersion by vortex structures in free shear flows.** Troutt, T.R. (Washington State Univ., Pullman (USA)); Crowe, C.T.; Chung, J.N. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Experimental and numerical results concerning solid particle dispersion in plane mixing layers and wakes are presented which demonstrate the importance of large scale vortex structures in the dispersion process. A time scale ratio involving the aerodynamic response time of the particles and a characteristic time of the vortex structures has been found to be an important parameter for indicating the qualitative and quantitative nature of the dispersion process. A stretching and folding mechanism associated with vortex development and amalgamation is suggested as a possible description of the particle dispersion process in mixing layers. for the plane wake flow where vortex amalgamations are rare, a highly organized particle focussing process occurs which concentrates intermediate size particles along the boundaries of the large scale vortices. The correlation dimension from chaotic theories appears to be a reasonable parameter for quantifying the relative organization of the dispersion patterns. 12 refs., 9 figs.

51402 (CONF-9005183–, pp. 19-26) **Chaotic mixing of immiscible fluids.** Ottino, J.M. (Univ. of Massachusetts, Amherst (USA)). Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The author reports results of on-going studies dealing with mixing and dispersion of immiscible fluids in chaotic flows. The objective is to understand basic processes in such a way as to be

able to exploit chaos to produce dispersions of controlled drop size. He provides a brief report of experimental, theoretical, and computational work. Experimental studies are restricted to low volume fractions; the computational work aims at describing breakup of highly elongated filaments in time dependent flows. He has observed qualitative features unique to nonlinear flows: breakup can occur in folds and there can be large variations of stretching and compression along the filament. He has been able to match experiments an computations for the deformation and breakup of highly stretched filaments, $O(10^3)$, and he has been able to show as well that long time limit of the drop size distribution is adequately described by means of scaling distributions. 11 refs., 1 fig.

51403 (CONF-9005183–, pp. 27-34) **The analysis of void wave phenomena.** Park, J.W. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Drew, D.A.; Lahey, R.T. Jr. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Void wave propagation phenomena in two-phase bubbly flows has been investigated. A linear dispersion relationship has been derived using a one-dimensional two-fluid model to investigate void wave dispersion in bubbly flows. The relaxation time, which mainly depends on the phasic slip, was found to be a key parameter for void wave dispersion. The model presented herein also shows the existence of a complementary kinematic wave which is related to the kinematic wave speed and the characteristics. Performing a Galilean transformation on the system of conservation equations, different types of nonlinear void wave phenomena, such as solitons, shocks and rarefactions, and their respective celerities, are predicted. The sensitivity of linear and nonlinear void wave propagation phenomena to important constitutive relations, such as virtual mass, interfacial pressure difference, and two-phase turbulence, are demonstrated. The virtual mass force was found to be crucial in determining void propagation in bubbly flows. 10 refs., 6 figs.

51404 (CONF-9005183–, pp. 68-70) **Thermodynamics of chemical systems with multiple stationary states.** Ross, J. (Stanford Univ., CA (USA)). Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

A summary is presented of a formulation of thermodynamics, and its connectin with stochastic theory, for chemical systems far from equilibrium with multiple stationary states. The theory provides necessary and sufficient conditions of global stability and a generalization of fluctuation theory to such systems. 7 refs.

51405 (CONF-9005183–, pp. 71-78) **Energy and mass transport in mesoscale structures.** Bau, H.H. (Univ. of Pennsylvania, Philadelphia (USA)); Harley, J.; Hava, S.; Kricka, L.; Pfahler, J.; Torao, A.; Wilding, P.; Urbanek, W.; Wang, T.K.; Weisberg, A.; Zemel, J.N. Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-88ER13964. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Using current micromachining methods, structures with lateral scales, S, of 150 nm $\{ <= \} S \{ <= \}$ 150 μm and heights, H, of 15 nm $\{ <= \} H \{ <= \}$ 150 μm can be made. Energy and mass transport in this dimensional regime has been limited so far because of manufacturing difficulties. Recent results on the spectral angular polarized thermal emission from relatively shallow gratings, i.e. $H \sim 3$ μm, with repeat distances, Λ, comparable to the emitted wavelength, λ, i.e. $0.1\lambda \{ <= \} \Lambda 10\lambda$, is discussed. Other studies on very thin channels, H = 0.48 μm and 3.0 μm, are also discussed. It has been argued that flow size effects should only arise when fluid molecular diameters are comparable to channel size. Nevertheless, the experimental results deviate from the classical Navier-Stokes friction law predictions when $H \{ <= \}$ 5 μm. Additional experimental and theoretical studies are needed to clarify the status of transport in this regime. 20 refs., 9 figs., 2 tabs.

51406 (CONF-9005183–, pp. 79-86) **Microcomputer enhanced optical investigation of transport processes in thin liquid films.** Sujanani, M. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Wayner, P.C. Jr. Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-89ER14045. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The near-equilibrium thickness profiles in the contact line region of a completely wetting fluid on an inclined flat plate were measured using an ellipsometer and a microcomputer enhanced interferometer. The extreme sensitivity of the system to the non-equilibrium effects associated with volatile liquids is demonstrated and evaluated. The new procedures allow the interfacial properties of the system to be unambiguously evaluated in situ at the start of dynamic studies. The convenience of microcomputer enhanced video microscopy naturally leads to a better understanding of the transport processes in the contact line region. The near-equilibrium processes of change-of-phase heat transfer and fluid flow in stationary and in spreading thin films are intrinsically connected because of their common dependence on the intermolecular force field and gravity. 10 refs., 5 figs.

51407 (CONF-9005183–, pp. 87-94) **Highly subcooled, high velocity film and transition boiling.** Sankaran, S. (Univ. of Houston, TX (USA)); Witte, L.C. Argonne National Lab., IL (USA). [1990]. DOE Contract FG05-88ER13893. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The intent of this study was to determine the influence of high subcooling and velocity on the ratio of minimum to maximum heat flux. Experiments were conducted at subcooling levels up to 58 C and at velocities up to 3.81 m/sec. While both q_{min} and q_{max} were sensitive to velocity and subcooling, the q_{min} to q_{max} ratio was seen to be a stronger function of subcooling than velocity. Discontinuities in measured wall temperatures were observed when the vapor film collapsed over certain portions of the heater prior to the entire heater being enveloped in nucleate boiling. These discontinuities are caused by film and nucleate boiling coexisting in near proximity close to the location of thermocouples mounted to measure heater local temperatures. It was also observed that the bottom of the heater underwent an unexpected temperature drop during nucleate boiling for high levels of subcooling. Such temperature drops were very repeatable. They resemble the temperature overshoot phenomena that have been observed in pool boiling experiments on a variety of heating surfaces and configurations. However, no observable significance increase in nucleation that is generally considered to be responsible for such behavior was found in their experiments. 13 refs., 8 figs., 1 tab.

51408 (CONF-9005183–, pp. 95-102) **Ultimate limits of boiling heat fluxes.** Vandervort, C.L. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Bergles, A.E.; Jensen, M.K. Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-89ER14019. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

An experimental study of subcooled boiling heat transfer is being performed at heat fluxes that have thus far ranged up to 10^8 W/m^2. This mode of heat transfer is limited by the occurrence of the critical heat flux (CHF) condition. Experiments were performed with stainless steel tubes having diameters ranging from 0.3 to 2.7 mm. Mass fluxes ranged from 5,000 to 40,000 kg/m^2-s, and subcoolings

from 40 to 135°C. The CHF was shown to be an increasing function of both velocity and subcooling, and a strong inverse function of diameter. Length-to-diameter ratio was varied from 2 to 25 and CHF increased for ratios less than 10. Exit pressure, which was held constant at either 6 or 12 bar, had a less significant effect. Difficulties with flow instabilities were encountered for several series of tests and possible explanations are offered. A high flux CHF data base is being compiled and development of a correlation is anticipated. 19 refs., 6 figs.

51409 (CONF-9005183–, pp. 129-136) **Evolution of interfacial disturbances in horizontal gas-liquid flows.** McCready, M.J. (Univ. of Notre Dame, IN (USA)); Jurman, L.A.; Peng, C.A.; Deutsch, S.E. Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-88ER13913. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Interfacial waves in a cocurrent gas-liquid channel flow are examined in the vicinity of neutral stability. It is seen that a fundamental mode, which corresponds well to predictions of the fastest growing mode from linear stability theory, forms first followed by at least 1 overtone. Depending upon flow rates and liquid depth, side band interactions or the formation of a subharmonic may occur. As the gas velocity is increased, transverse variations may also become important. Mode interaction equations derived from nearly-inviscid theory are shown to be appropriate for describing these waves for liquid Reynolds numbers O(10) if the wavelengths are not too long compared to layer depth. For lower liquid Reynolds numbers and longer wavelengths, mode interaction equations derived from boundary-layer theory are proposed. The types of interactions identified here are expected to be important for interfacial waves over a wide range of conditions. 20 refs., 8 figs.

51410 (CONF-9005183–, pp. 137-143) **Experimental and theoretical studies of condensation dynamics in a supersonic nozzle.** Frish, M.B. (Physical Sciences Inc., Andover, MA (USA)); Wilemski, G. Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Spatially-resolved interferometry and laser light scattering data have been combined with the diabatic gasdynamic equations to deduce approximate sizes and number densities of water droplets through the condensation region in a supersonic expansion. The results suggest that a polydisperse size distribution favors growth of large droplets at the expense of smaller ones. Theoretical cluster size distributions have been computed as a function of distance from the nozzle throat. Nonsteady effects due to the variation of temperature and pressure in the isentropically expanding gas are explicitly included. The results indicate that it is not possible to cleanly distinguish between nucleation and condensational growth stages early in the expansion. Even before the observable onset of condensation, quite large clusters are already present. 6 refs., 9 figs.

51411 (CONF-9005183–, pp. 144-151) **Numerical methods for the simulation of inertial coupling in disperse two-phase flow.** Sangani, A. (Syracuse Univ., NY (USA)); Kim, H.S.; Prosperetti, A.; Zhang, D.Z. Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-89ER14043. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Two techniques for the numerical simulation of the dynamics of rigid massless spheres in an inviscid incompressible liquid are described. For the first one the velocity potential is expressed as a superposition of singularities, while the second one involves the values of the potential on the flow boundaries. The results obtainable in this way are illustrated by calculating the added mass and drag coefficients at large volume fractions and the motion of a number of bubbles in a nozzle. 11 refs., 6 figs.

51412 (CONF-9005183–, pp. 152-159) **Pairwise interactions and attenuation of sound in bubbly liquids.** Sangani, A. (Syracuse Univ., NY (USA)). Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-89ER14043. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

A theory is described for determining the pairwise interactions among bubbles in a dilute bubbly liquid and their effect on the attenuation of low intensity acoustic waves. The theory is shown to yield estimates of attenuation that are in a good agreement with the experimental data available in the literature for frequencies that are close to the resonance frequency of the bubbles. 7 refs., 3 figs.

51413 (CONF-9005183–, pp. 175-181) **Energy and particle transport in stochastic mixtures.** Pomraning, G.C. (Univ. of California, Los Angeles (USA)). Argonne National Lab., IL (USA). [1990]. DOE Contract FG03-89ER14016. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The author discusses the formulation of linear transport and kinetic theory describing energy and particle flow in a random mixture of two or more immiscible fluids. Included in this discussion are: (1) the method of smoothing and the Liouville master equation approaches in the case of Markovian statistics as the description of the fluid mixing; (2) the use of asymptotics to derive various limiting descriptions of the Markov model; (3) the use of the theory of alternating renewal processes to obtain an integral equation formulation for non-Markovian statistics; and (4) the reduction of this non-Markovian integral formulation to differential equations with statistical effects represented by pseudo-scattering terms. 21 refs.

51414 (CONF-9005183–, pp. 182-189) **Experiments in turbulent mixing.** Warhaft, Z. (Cornell Univ., Ithaca, NY (USA)). Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-88ER13929. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The author summarizes recent experiments on fully developed turbulent mixing of scalars (both passive and active) at moderate Reynolds numbers. The emphasis is on mixing in which there is more than one dominant spectral scale. The first experiment concerns linearly and stepwise stably stratified grid generated air turbulence with temperature causing the stratification. He shows that as the stratification is increased the heat flux is suppressed and under the strongest stability a counter gradient heat flux occurs. Here the vertical kinetic energy of the flow increases as it is fed from the potential energy field. The second experiment concerns the evolution of a passive thermal line source placed in the center of a turbulence mixing layer in which two mechanical turbulence scales are produced by a composite grid. There is no shear. He shows that the median of the plume is deflected into the large scale (more energetic) region initially (in the convective regime) and then latter (in the turbulent diffusive regime) it is deflected into the small scale region. The mean and variance profiles are strongly skewed. For both experiments spectra and budgets are described and the results are related to environmental and industrial mixing problems. 10 refs., 9 figs.

51415 (DOE/ER/13800–T2) **The impact of separated flow on heat and mass transfer: Progress report.** Goldstein, R.J.; Jabbari, M.Y. Minnesota Univ., Minneapolis, MN (USA). Dept. of Mechanical Engineering. [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13800. Order Number DE91000592. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An investigation of the effect of flow separation on heat (or mass) transfer is underway. This research, sponsored by the Department of Energy (Contract No. FG02-87ER13800), is planned to enhance our understanding of the fundamental mechanisms governing the process. This report summarizes previous accomplishments and briefly describes works done during period May 1, 1989 through April 30, 1990. Future plans and studies under preparation are also mentioned. 8 refs., 7 figs.

51416 (GRS–73) **Phase separation and swell level dynamics in transient two-phase flows.** Steinhoff, F. Gesellschaft fuer Reaktorsicherheit mbH (GRS), Garching (Germany, F.R.); Technische Univ. Muenchen (Germany, F.R.). Fakultaet fuer Maschinenwesen. Sep 1989. 152p. (In German). Order Number DE91706105. Source: NTIS (US Sales Only), PC A08/MF A01.

Starting from the basic version of the computer program DRUFAN-01, the system code DRUFAN-02 was developed. This makes an advanced system code for PWR's and the limitations for BWR's available, by which the pressure release and refilling phase can be analysed for loss of coolant (LOCA) accidents. The fault spectrum of the code includes large, medium-sized and small leaks and selected operating transients. There are limitations regarding the flood phase occurring for large fracture crossections. The program is suitable for carrying out the emergency core cooling analyses required in the BMI safety criteria and accident guidelines. The development work included mainly the extension of the thermal and fluid dynamics model with regard to the simulation of separation processes and mixture level movements in vertical flow channels during pressure reduction processes and also the inclusion of models for heat conduction and heat generation in structures, heat transfer between fluid and structures, component simulation and control and regulation processes. (orig./GL).

51417 (LA–11692-MS-Vol.2) **AFDM: An Advanced Fluid-Dynamics Model: Volume 2, Topologies, flow regimes, and interfacial areas.** Wilhelm, D. Los Alamos National Lab., NM (USA). Sep 1990. 123p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-7405-ENG-36. Order Number DE91000581. Source: NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This volume describes the Advanced Fluid-Dynamics Model (AFDM) for topologies, flow regimes, and interfacial areas. The objective of these models is to provide values for the interfacial areas between all components existing in a computational cell. The interfacial areas are then used to evaluate the mass, energy, and momentum transfer between the components. A new approach has been undertaken in the development of a model to convect the interfacial areas of the discontinuous velocity fields in the three-velocity-field environment of AFDM. These interfacial areas are called convectible surface areas. The continuous and discontinuous components are chosen using volume fraction and levitation criteria. This establishes so-called topologies for which the convectible surface areas can be determined. These areas are functions of space and time. Solid particulates that are limited to being discontinuous within the bulk fluid are assumed to have a constant size. The convectible surface areas are subdivided to model contacts between two discontinuous components or discontinuous components and the structure. The models have been written for the flow inside of large pools. Therefore, the structure is tracked only as a boundary to the fluid volume without having a direct influence on velocity or volume fraction distribution by means of flow regimes or boundary layer models. 17 refs., 7 tabs., 18 figs.

51418 Central difference-like approximation for the solution of the convection-diffusion equation. Tzanos, C.P. (Reactor Analysis and Safety Div., Argonne National Lab., Argonne, IL (US)). *Numerical Heat Transfer, Part B: Fundamentals (USA)*, 18(1): 97-112 (1990).

This paper reports on a method developed for the numerical solution of the convection-diffusion equation. It is based on a central difference-like approximation and the requirement that cell face values of the convected variable must be bounded by their adjacent cell center values. To evaluate its performance, a two-dimensional problem that has been used in the literature to test a large number of methods was used as a benchmark.

4205 Materials Testing

Refer also to citation(s) 51168, 51178, 51630

51419 (CONF-9005183–, pp. 221-228) **Recent advances in ultrasonic NDE techniques.** Hsu, D.K. (Iowa State Univ., Ames (USA)); Thompson, D.O. Argonne National Lab., IL (USA). [1990]. DOE Contract W-7405-ENG-82. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Advances were made in three areas of ultrasonic nondestructive evaluation. In the first area, piezoelectric transducers with Gaussian and Bessel beam profiles were produced using a nonuniform poling technique. The measured field profiles compared well with theoretical predictions. The fields of a Gaussian transducer are simple to compute and hence desirable for quantitative NDE. The Bessel transducers have the potential of producing diffractionless beams and are therefore technologically important. In the second area, an ultrasonic imaging method was developed using the area function derived from the ultrasonic scattering signal. The area function is analogous to the monochromatic ray sum of parallel-beam x-ray computerized tomography. Using this relationship, two dimensional images representing the dimension of the target in a direction normal to the viewing plane were constructed. The method was demonstrated using both synthetic and experimental data and represented an extension of ultrasonic imaging to more generally-shaped targets. Finally, properties of high T_c ceramic superconductors were evaluated using ultrasonic, eddy current and radiographic NDE methods; preliminary results are described. 11 refs., 5 figs.

51420 (CONF-9005183–, pp. 229-236) **Effects of distributed microcracking on effective wave speed and attenuation of ultrasound.** Achenbach, J.D. (Northwestern Univ., Evanston, IL (USA)). Argonne National Lab., IL (USA). [1990]. DOE Contract FG02-86ER13484 ;FC05-85ER25000. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

The development of distributed microcracking gives rise to changes in the wave speed and attenuation of ultrasonic signals. In this paper results are presented for surface waves propagating over a free surface containing distributed surface-breaking cracks. The results are based on scattering by a single surface-breaking crack. The scattering cross-section of such a crack is employed as a measure of energy removal from the incident surface wave, and energy considerations are subsequently employed to obtain the coefficient of attenuation. Use of the Kramers-Kroenig relation yields an expression for the phase velocity. Numerical results are given as functions of the crack density, a characteristic length dimension of the crack and the frequency. The theoretical framework provided in this paper potentially applies to the use of surface waves for the characterization microcracking of high-temperature superconducting materials. 3 refs., 3 figs.

51421 (LA-UR–90-2988) **High-precision density measurements using tomography.** Morris, R.A. (Los Alamos National Lab., NM (USA)); Harris, L.D. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900791–4: Review of progress in quantitative NDE, La Jolla, CA (USA), 15-20 Jul 1990). Order Number DE91000436. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As part of the quality assurance program at the Los Alamos National Laboratory, the physical density of high explosives must be measured to an accuracy of 0.05%. At the present time this measurement is done destructively on a sampling basis. This work is the report on the first phase of a program to determine the feasibility of using a tomographic inspection to do a 100% inspection nondestructively. The goal of this phase was to determine the precision with which a commercial tomographic system could measure

density. A measurement of the absolute accuracy to which such an inspection could be made would be done later. Two innovative ideas were incorporated into this experiment. First, the absolute density of the plastic phantom was varied by changing the temperature of the phantom with a water bath. Secondly, the effects of beam hardening, scatter, off-focal radiation, and local inhomogeneities in the phantom were eliminated by using the phantom itself as the calibration standard. 3 figs., 1 tab.

51422 (SAND–90-1291) **Using power series expansions of moduli to interpolate between release curves from dynamic tests: Technique and application.** Furnish, M.D. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 43p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE91000091. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recently an appreciable number of continuous release profiles have been measured from dynamic experiments with geological materials. For each material an empirical generalization of the available release curves may be constructed to allow easy application of the experimental data to problems in much the same way as a linear shock velocity – particle velocity fit allows easy application of Hugoniot data. This generalization is made in two steps. The first is to compute the Eulerian axial modulus at the Hugoniot pressure and its first three pressure derivatives along the release for each test. This corresponds to a partial Taylor series of the axial modulus, which integrates to give a very close match to the original release. An alternative formulation, which takes volume as the independent variable, fails because that Taylor series does not converge with the rapidity needed for these calculations. The second step is to plot each of these quantities against the Hugoniot pressure for the suite of tests, and fit these data. A release from an arbitrary pressure within the general range of the experimental data may be computed by using the interpolated modulus and its interpolated derivatives. This generalization, which allows volume to be computed as a function of pressure, reproduces the experimental curves fairly well. We present the results of applying this technique to release data for Mini Jade 2 grout, and briefly compare these results with those from several Nevada Test Site tuffs, saturated and dry Indiana Limestone, and aluminum. Finally, we use the generalized Mini Jade 2 data to solve a sample problem, that of estimating the error produced by making the "release = Hugoniot" assumption in the analysis of ground motion gauges in an underground test. 12 refs., 14 figs., 5 tabs.

51423 (UTNL-R–0246) **Reports from the Yayoi symposium on quantitative non-destructive evaluation, (1): Application to the atomic energy; Inverse problem and imaging technology.** Tokyo Univ., Tokai, Ibaraki (Japan). Nuclear Engineering Research Lab. Feb 1990. 124p. (In Japanese). (CONF-8912119–: Yayoi symposium on quantitative non-destructive evaluation, Tokai (Japan), 4-5 Dec 1989). Order Number DE91713089. Source: NTIS (US Sales Only), PC A06/MF A01.

The report consists of four parts. The first part deals with nondestructive evaluation in the nuclear power industry, focusing on in-service inspection in nuclear power plant, eddy current crack detection test of steam generator heat-exchanger tube, and nondestructive test of thin-wall components. The second part discusses inverse problems and quantification for nondestructive evaluation, centering on the identification of defect by boundary element method, quantification by using supersonic wave, defect shape recognition by the electrical potential method, and a neural network applied to crack type recognition. The third part deals with the application of electromagnetic phenomena to nondestructive evaluation, focusing on a superconducting quantum interference device, electromagnetic measurement in the iron industry, and nondestructive measurement of residual stress by magnetic process. The fourth part discusses visualization techniques for nondestructive evaluation, focusing on image processing, neutron radiography, X-ray CT, defect diagnosis by infrared rays, and visualization of magnetic field. (N.K.).

4210 Combustion Systems

Refer also to citation(s) 50361, 51380, 51414

51424 (ALS/TR–90-017) **Control of oscillatory burners operating on the principle of pulsating, that is, periodically detonating, combustion.** Schoel, G. (VEB Dampferzeugerbau, Berlin (German Democratic Republic)). Sandia National Labs., Albuquerque, NM (USA). 25 Jul 1990. 9p. Translation of German Patent Application 1 110 800, July 9, 1957. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE91000879. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This invention relates to a method and a device for the control of oscillatory burners operating on the principle of pulsating, that is, periodically detonating, combustion. 2 figs.

51425 **Pulse combustion: The mechanisms of NOsub x production.** Keller, J.O. (Sandia National Labs., Livermore, CA (USA). Combustion Research Facility); Hongo, I. *Combustion and Flame (USA),* 80(3): 219-237 (Jun 1990).

A study has been performed to elucidate the fundamental mechanisms controlling the production of NO in a Helmholtz-type pulse combustor. Cycle-resolved measurements of velocity and temperature in the combustion chamber were made. These measurements were combined with the Zeldovich NO formation mechanism to explain the mechanism responsible for the low NO formation found in pulse combustors. The mechanism responsible for low NO formation found in pulsating flow as compared to nonpulsating flow was found to be a short residence time at high temperature. Three different possible mechanisms for this short residence time are investigated: hot products from combustion are cooled by mixing with the cooler exhaust gases entering the combustion chamber from the tail pipe, thus quenching the NO formation reaction (automatic exhaust gas recirculation), hot combustion products are quickly cooled by mixing with the incoming cold reactants, and residual products with a lower overall temperature (due to an increased rate of heat transfer in the combustion chamber) readily mix with hot products producing a short residence time at high temperature. It is shown that the mechanism responsible for the low NO emission in pulse combustors is a result of the third item.

51426 **Time-resolved gas temperatures in the oscillating turbulent flow of a pulse combustor tail pipe.** Dec, J.E. (Michigan Univ., Ann Arbor, MI (USA)); Keller, J.O. *Combustion and Flame (USA),* 80(3): 358-370 (Jun 1990).

This paper reports the cyclic behavior of the gas temperature in the oscillating turbulent flow in a pulse combustor tail pipe studied using two-line atomic fluorescence. In this flow, the oscillations result from an acoustic resonance, and have amplitudes of up to 5 times the mean velocity. Oscillation frequencies were varied from 67 to 101 Hz. Spatially resolved temperature measurements were made to within 400 μm of the wall, providing cycle-resolved profiles of the temperature and the random temperature fluctuations. The combustor-cycle phase relationships among the gas temperature, random-temperature-fluctuation intensity, velocity, and combustion chamber pressure, are compared.

4220 Mining and Underground Engineering

Refer also to citation(s) 50690, 50706, 50707, 51884

51427 (TAC–CE03154) **Canadian tunnelling, 1987/88.** Eisenstein, Z. (ed.). Tunnelling Association of Canada (Canada). 1988. 237p. (CE–03154). Source: BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN.

A compilation is presented of papers concerning advances in the theory and practice of tunnelling and underground construction. The compilation features mainly original papers or those presented at a tunnelling conference held in Niagara Falls, Ontario, in 1986. Topics of papers include the history and future of Canadian tunnelling, design of lined and unlined pressure tunnels, ground control in railway tunnels, design of underground structures, diversion tunnels, and geomechanical considerations. Separate abstracts have been prepared for 2 papers from this compilation.

51428 (TAC–CE03155) **Canadian tunnelling, 1989.** Eisenstein, Z. (ed.). Tunnelling Association of Canada (Canada). 1989. 271p. (CE–03155). Source: BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN.

A compilation is presented of papers on various aspects of Canadian tunneling research and experience. Papers are included from a tunnelling conference held in Toronto in 1989 as well as original papers from around the world. Topics of papers include hydroelectric power tunnels, railway tunnel construction and design, design and performance of vertical shafts, microcomputer techniques in geologic mapping, tunnels in swelling rock, tunnel instrumentation analysis, road tunnels, ventilation systems, use of tunnel boring machines, drilling equipment used for underground structures, construction of drainage adits, the New Austrian Tunnelling Method, tunnel construction management, and cooling water tunnels for nuclear power plants. Separate abstracts have been prepared for 2 papers from this compilation.

4230 Marine Engineering

51429 (CSCE–CE03156, pp. 448-463) **Combined wave-current forces on cylinders.** Isaacson, M. (Univ. of British Columbia, BC (Canada)); Niwinski, C.; Hughes, B. Canadian Society for Civil Engineering, Montreal, PQ (Canada). 1989. (CONF-8906366–: Annual conference and the 9th Canadian hydrotechnical conference, St. John's (Canada), 8-10 Jun 1989; CE–03156). In *Annual conference and the 9th Canadian hydrotechnical conference: Volume 2A and 2B. Proceedings*. 828p. Source: Canadian Society for Civil Engineering, 2050 Mansfield St., Montreal, PQ, CAN. Prices: $40.00 CAN.

The hydrodynamic loads on offshore structures are generally due to the combined action of waves and currents. Tests carried out on slender cylinders in a wave-current flume revealed significant changes in the maximum in-line force with changes in the magnitude of the current superposed on the incident waves. The Morison equation was found to accurately predict the force for the no-current case. However, when combined wave-current results were compared to predictions based on the relative velocity formulation of the Morison equation using no-current values for drag and inertia coefficients, the Morison equation was found to overpredict the measured forces. Experiments with two large cylinders in a wave basin confirmed that wave forces on strucutres in the diffraction regime may also be significantly altered by the presence of a current. The results provide some indication of the relationship between in-line force and current strength, structure size, and wave steepness. In general, the largest forces occurred for positive (following) currents, while the smallest forces were associated with the strongest opposing currents. 5 refs., 9 figs.

51430 (GKSS–89/E/59) **Underwater technology - a high tech market with future.** Luther, G. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Anlagentechnik). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 21p. (In German). Order Number DE91712416. Source: NTIS (US Sales Only), PC A03/MF A01.

The difficult Northsea conditions are the background and basis for the development of new offshore technologies by European companies. The amount of money spent for R and D ranges up to 1 billion Deutsche Mark per year. The larger part of this volume is spent for the development of safe and efficient underwater techniques. Developments related to diving are part of these activities. The large volume of financial expenditures demonstrates the amount of High-Tech that is produced by or needed for this market. (orig.) With 5 diagrams, 5 tabs.

51431 (OTI–89-544) **Sensitivity of the reliability of a fixed offshore platform -an investigation using Level II techniques.** Williams, R. (Lloyd's Register of Shipping, London (GB)); Tsivanidis, H. Department of Energy, London (UK). Offshore Energy Technology Board. 1989. 74p. Source: Also available from H.M. Stationery Office, price Pound 13.75.

The design of an offshore platform is checked currently by a series of deterministic calculations using characteristic values of the parameters which define the materials, geometry and environmental loading. The risk inherent in such calculations depends on the possibility of the characteristic values being exceeded in practice and on the sensitivity of the strength and loading to changes in these parameters. A reliability calculation to quantify the risk involved requires expressions to represent the strength and loading in terms of the basic parameters; and probability distributions giving the likely variation of these parameters over the design life of the structure. A large number of studies sponsored by the Department of Energy have been carried out recently to investigate the sensitivity of offshore structures to uncertainties in design parameters. (author).

51432 (OTO–89-009) **Static strength of tubular compression members: calibration of API and DnV codes.** Department of Energy, London (UK). Offshore Energy Technology Board; Wimpey Offshore, London (UK). Apr 1988. 80p. (WOL–238-88). Source: Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.

Offshore structures are designed in accordance with a number of recognised design codes, the selection of the code generally being made on the basis of national preference and established practice. In the North Sea, two codes in particular are very widely used; the API code, together with the closely related AISC code, is established as the leading code for the design of steel structures in the U.K. sector, and the DnV code is similarly established in the Norwegian sector. The major design codes frequently have very different origins, and are based on differing design approaches. Because of the inherent complexity of design codes, the relative conservatism embodied in each code is not immediately apparent. This creates difficulties for statutory bodies and Certifying Authorities in deciding which codes are most appropriate in a given situation, and whether any modifications to the codes are necessary. (author).

51433 (UEG-Pub-UR–37) **Offshore structures: design/fabrication interface.** Hordyk, M. (Billington Osborne-Moss Engineering Ltd. (GB)). Construction Industry Research and Information Association Underwater Engineering Group (CIRIA/UEG), London (UK). 1988. 39p. Source: Available from CIRIA/UEG, 6, Storey's Gate, Westminster, London SW1P 3AU, price Pound 30.00.

For some years there has been recognition from all sides of the offshore industry that the separation of designers and fabricators is the cause of unnecessarily expensive structures. The technical director of George Wimpey plc, described the gulf between the two as 'feudal' in his keynote presentation to a London conference in November 1984. This conference brought together the several disciplines working together (or separately) to design and fabricate offshore facilities, in an attempt to pool their experience and ideas so that more economic offshore installations could be produced in future. (author).

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 50891, 50892, 50990, 51148, 51174, 51176, 51194, 51215, 51220, 51249, 51299, 51492, 51495, 51578, 51580, 51581, 51582, 51586, 51598, 51599, 51608, 51976, 51977, 51978, 51979, 51980, 51985, 51986, 51987, 51988, 51989, 52047, 52379, 52421, 52444, 52445, 52446, 52447, 52449, 52450, 52451, 52470, 52528, 52536

51434 (AD-A–223562/0/XAB) **Pyyromethene-BF_2 complexes as laser dyes. Technical report No. 17, 1 June619 89-31 May 1990.** Shah, M.; Thangaraj, K.; Soong, M.L.; Wolford, L.T.; Boyer, J.H. Naval Ocean Systems Center, San Diego, CA (USA). 24 May 1990. 27p. Source: NTIS, PC A03/MF A01.

In 1984, less than two decades after its discovery, a review described the dye laser as one of the most useful and practical of tunable coherent sources. Laser dye activity was presumed to reflect a casual relationship with various ancillary properties including photostability, solubility and other interactions with solvent, fluorescence quantum yield, molar extinction of absorption, and minimal overlap of fluorescence with onset of absorption spectral regions, (S-S) and triplet-triplet (T-T). Bathochromic and hyperchromic shifts were introduced by the substitution of auxochromic and antiauxochromic groups but this benefit was often offset by the ability of certain groups, e.g. nitro, cyano, and heavy atoms, to quench laser activity. Since the known dyes were each deficient in one or more properties the search for new structures to offer superior performance standards was undertaken.

51435 (AD-A-223714/7/XAB) **Monolithic two-dimensional GaAs/AlGaAs laser arrays fabricated by chlorine ion-beam-assisted micromachining.** Goodhue, W.D.; Rauxchenbach, K.; Wang, C.A.; Donnelly, J.P.; Bailey, R.J. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1990. 8p. Contract F19628-90-C-0002. (JA-6402). Source: NTIS, PC A02/MF A01.

Pub. in Jnl. of Electronic Materials, Vol. 19, No. 5, 463-469(1990).

Chlorine ion-beam-assisted etching (IBAE) has been used to micromachine laser facets and deflecting mirrors for monolithic two-dimensional GaAs/AlGaAs laser arrays. Three laser cavity/deflector designs have been successfully implemented. The first utilizes a parabolic deflecting mirror to directly focus the laser radiation; the second consists of a folded cavity with a vertical facet, a top surface facet, and an internal 45 C reflector; and the third has a folded cavity with an internal $Al_{0.2}Ga_{0.8}As/Al_{0.8}Ga_{0.2}As$ dielectric mirror stack and a top surface facet formed in a single etch step with two internal 45 C reflectors. The parabolic deflecting mirrors are currently modeled for f-0.8 collection efficiency, making the first design attractive incoherent arrays for high-power applications such as pumping Nd:YAG lasers.

51436 (AD-A-223716/2/XAB) **High-power hybrid two-dimensional surface-emitting AlGaAs diode laser arrays.** Donnelly, J.P.; Rauschenbach, K.; Wang, C.A.; Bailey, R.J.; Walpole, J.N. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1990. 11p. Contract F19628-90-C-0002. (MS-8651). Source: NTIS, PC A03/MF A01.

Pub. in SPIE - (The International Society for Optical Engineering), Laser -Diode Technology and Applications II, Vol. 1219, 254-263(1990).

The fabrication and performance of hybrid two-dimensional surface-emitting AlGaAs(Aluminum Gallium Arsenide) diode laser arrays, in which linear arrays of edge-emitting lasers with cleaved end facets are mounted on microchannel Silicon heat sinks with integral 45 deg deflecting mirrors, are discussed.

51437 (AD-A-223767/5/XAB) **Closed-cycle excimer laser conceptual design effort. Phases 1 and 1A. Final report, 17 September 1980-1 November 1981.** Avco-Everett Research Lab., Everett, MA (USA). Jun 1982. 200p. Contract DAAH01-80-C-1783. Source: NTIS, PC A09/MF A02.

The program is divided into two phases, Phase I and Phase IA. The Phase I effort was directed towards a conceptual design of a small closed cycle XeF laser system with a closed cycle XeF laser as the driver. This report deals with work performed under the Phase IA effort. The XeF laser serves to integrated laser technologies and to provide a test bed for addressing scaling issues. Scaling is of interest for a practical Raman shifted blue-green laser ground based communications system. Scaling to higher powers for weapons application is also of interest. The reported conceptual design meets all performance requirements. Demonstrated technologies are used wherever possible. The device is aimed at addressing all critical technologies including high reliability, high overall efficiency (> or = 1%) and good beam quality (> or = 1.3 DL). Component and system trade-offs were conducted to produce a baseline design. These studies point to areas where improvements in existing technologies are warranted. Scaling issues and the extent to which they are addressed by the XeF integrator are given. Recommendations are made for critical experiments.

51438 (CONF-900801-31) **Phenomenology of forces acting between magnets and superconductors.** Hull, J.R. (Argonne National Lab., IL (USA)); Mulcahy, T.M.; Lynds, L.; Weinberger, B.R.; Moon, F.C.; Chang, P.Z. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90017864. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The forces acting between magnets and superconductors give rise to a rich diversity of phenomena that are understood physically only at a rudimentary level. Experimental results are presented for the levitational force, magnetic stiffness, drag, and damping of magnets interacting with high-temperature superconductors. Empirical correlations and theoretical understanding of these phenomena are summarized. The use of high-temperature superconductors in prototype experimental bearing devices is described.

51439 (CONF-9005183-, pp. 197-204) **Cryotribology and cryomechanics for superconducting magnet technology.** Iwasa, Y. (Massachusetts Institute of Technology, Cambridge (USA)). Argonne National Lab., IL (USA). [1990]. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

This paper discusses important design issues for high-performance superconducting magnets, those nearly adiabatic magnets having high overall current density used in such applications as nuclear magnetic resonance (NMR) spectroscopy, magnetic resonance imaging (MRI), the superconducting supercollider (SSC), and magnetic levitation (maglev). More specifically, it discusses the important role that cryotribology and cryomechanics - tribology and mechanics at cryogenic temperatures - plays in advancing their understanding the nature of mechanical disturbances that occur in the winding of these magnets. Mechanical disturbances are perhaps the most important sources of energy dissipation in the winding that are still intractable. Nevertheless, the author has achieved significant progress over the past 10 years in understanding their sources, mechanisms, the range of magnitudes and spatial extent, and even ways to minimize their occurrence. This paper summarizes his recent results. 27 refs., 5 figs., 1 tab.

51440 (IFVE-ONF-89-46) **Time-variant filters. Part 1.** Krasnokutskij, R.N. (and others); Kurchaninov, L.L.; Fedyakin, N.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 13p. (In Russian). Order Number DE91604781. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to NIM and Instrum. Exp. Tech.

The noise analysis for an ideal voltage amplifier with a time-variant filter has been performed. The filter has a F1-switch-F2 filter structure. Two types of F1 are considered: ideal differentiator and noise-whiter (w). Pulse response of F2 was varied. It is shown that in all cases the equivalent noise charge (ENC) is not better than for the optimum time-invariant filter. It is shown that for the case of W-switch-double integrator ENC is always 1.6 more than for the optimum filter. 7 refs.; 2 figs.

51441 (LBL-26455, pp. 49) **The high-T_c superconducting bolometer.** Richards, P.L.; Verghese, S.; Geballe, T.H.; Spielman, S.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

A description is given of the optimization of a bolometric infrared detector that uses the resistive transition of a high-T_c film as the thermometer. The performance of a liquid nitrogen (LN)-cooled far-infrared bolometer operated with a cooled low-pass filter is computed for the ideal case of a noise-free readout. The theory is then extended to include various contributions to the readout noise. Measurements are presented of the low-frequency noise near T_c in current-biased films of $ErBa_2Cu_3O_7$, which show that useful performance can be achieved. Comparisons are made with other infrared detection technologies that show that practical high-T_c bolometers will be especially useful for wavelengths long the ~ 20-μm cutoff of LN-cooled photovoltaic detectors. Potential applications include far-infrared laboratory spectroscopy and passively cooled space observations of bright sources such as the earth.

51442 (LBL-26455, pp. 50) **Feasibility of the high-T_c superconducting bolometer.** Richards, P.L.; Clarke, J.; Leoni, R.; Lerch, P.; Verghese, S.; Beasley, M.R.; Geballe, T.H.; Hammond, R.H.; Rosenthal, P.; Spielman, S.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

A design analysis is given for a bolometric infrared detector that uses the resistive transition of a high-temperature superconductor as the temperature-sensing element, and LN as a coolant. The measured low-frequency noise for highly oriented c-axis films

causes little or no degradation of the performance. With the incoming radiation chopped at 10 Hz, a noise equivalent power (NEP) in the range (1-20) x 10^{-12} $WHz^{-1/2}$ should be achievable. These values compare favorably with the NEP of other detectors operating at or above LN temperatures for wavelengths greater than 20 μm.

51443 (LBL–26455, pp. 55) **Experimental solid-state physics and quantum electronics.** Shen, Y.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

This program involves theoretical and experimental research on laser interaction with matter. New nonlinear optical techniques are developed for studies of materials, both in the condensed-matter phase and in the gas phase. Current projects include (1) exploration of optical second-harmonic generation as a surface probe for noncentrosymmetric media; (2) development of sum-frequency generation for surface vibrational spectroscopy of adsorbed molecules at liquid/solid, air/metal, and air/semiconductor interfaces; (3) study of vibrational modes, including the local modes of benzene using the infrared-ultraviolet (IR-UV) double-resonance spectroscopic technique on supersonically cooled molecular beams; (4) far-UV high-resolution photoionization spectroscopic study of water molecules in a supersonically cooled beam; and (5) theoretical study of the localization of multivibrational excitations in a one-dimensional boson system with on-site random anharmonicity.

51444 (LBL–26455, pp. 68) **Superconductivity, superconducting devices, and 1/f noise.** Clarke, J. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

DC Superconducting QUantum Interference Devices (SQUIDs) based on a niobium technology are applied to a wide variety of applications, including geophysics, nuclear magnetic resonance, and the study of noise in high-temperature superconductors. Measurements on high-temperature superconductors such as YBaCuO, BiCaSrCuO, or TlCaBaCuO yield information concerning the dependence of the low-frequency magnetic-flux noise on temperature and the microstructure of the materials, and guide the design of devices operating at liquid-nitrogen temperatures. Measurements of voltage noise at the resistive transition of superconductors yield information on the nature of the transition and are used to design superconducting bolometers. Sensitive SQUID amplifiers involving a tuned input circuit and a novel Q-spoiler are used to detect nuclear magnetic resonance (NMR) and nuclear quadrupole resonance (NQR) in the frequency range 20-50 MHz. This system is being applied to magnetic resonance of surface layers. SQUIDs with superconducting input circuits are able to detect zero-field NMR or NQR at frequencies as low as 20 kHz in organic and amorphous materials. These data provide information on the magnetic fields and electric-field gradients at the active nuclei. Submicron tunnel junctions are being investigated at ultralow temperatures to test new theories of macroscopic quantum phenomena such as Bloch oscillations.

51445 (LBL–26455, pp. 69-70) **Low-field nuclear magnetic resonance with SQUID amplifiers.** Fan, N.Q.; Clarke, J.; Hahn, E.L.; Bielecki, A.; Pines, A. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

An NMR spectrometer based on a dc SQUID has been developed for frequencies below 250 kHz. The primary goal of this spectrometer is to perform NMR in zero magnetic field. As a preliminary demonstration, however, the authors have used the spectrometer to observe NMR in ^{195}Pt at 4.2 K with applied magnetic fields of a few tens of gauss. The flux-locked loop can track signals at frequencies up to 250 kHz. After the radiofrequency pulse in the transmitter coil is turned off, the integrator in the feedback loop is reset, and the voltage across the feedback resistor R_f is held at zero until the feedback circuit has stabilized. When the feedback circuit is enabled, the precessing nuclear spins in the sample induce an oscillating magnetic flux in the pickup coil that is coupled into the SQUID via a superconducting transformer. The signal from the flux-locked loop is filtered, amplified, and transmitted to the digital oscilloscope for time-domain analysis and the spectrum analyzer for frequency-domain analysis. The entire system is computer controlled. The spin of the ^{195}Pt nucleus is 1/2, and its gyromagnetic ratio is 0.95 kHz $gauss^{-1}$. It has a T_2 of 1.1 msec and a T_1 of 10 msec. The authors carried out the NMR experiments in magnetic fields ranging from 30 gauss to 200 gauss, applying a radiofrequency pulse every 0.5 sec to initiate the free-induction decay (FID).

51446 (SAND–89-0913) **Improved assembly processes for the Quartz Digital Accelerometer cantilever.** Romero, A.M.; Gebert, C.T. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 21p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AC04-76DP00789. Order Number DE91000096. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report covers the development of improved assembly processes for the Quartz Digital Accelerometer cantilever. In this report we discuss improved single-assembly tooling, the development of tooling and processes for precision application of polyimide adhesive, the development of the wafer scale assembly procedure, and the application of eutectic bonding to cantilever assembly. 2 refs., 17 figs.

51447 (SAND–90-1544) **Mode-stirred chamber measurements of the Shielding Effectiveness of select cables and connectors.** Toth, R.P.; Bacon, L.D. Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE91000466. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have determined experimentally the Shielding Effectiveness (SE) at microwave frequencies of various types of single- and double-braided cables and connectors typical of systems that have been hardened to electromagnetic fields. This report describes a laboratory-sized reverberation chamber and the techniques used to measure the SE of several interconnecting components. Graphical results are presented in the report, along with smoothed overlay plots for each category of measurements. The overlay plots indicate the general trends in the raw data and highlight the differences between tested components. 7 refs., 22 figs.

51448 (UCRL–98217) **High current ignitor development.** Cummings, D.B.; Kihara, R.; Leighton, K.S. Lawrence Livermore National Lab., CA (USA). 17 Jun 1988. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-880699–10: 18. power modulator symposium, Hilton Head, SC (USA), 20-22 Jun 1988). Order Number DE90015913. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An experimental 9-inch demountable ignitron has been built and tested. It has passed 178 pulses with peak currents up to 925 kA with 39 at 740 kA or greater. This is two to three times the useful limit of conventional ignitrons. Ignitor resistance has not dropped significantly which is the usual failure mode. The discharge is nearly critically damped with 160 us to peak and a charge transfer of 280 Coulombs with reverse current of 5% to 7%. This unique tube design has an annular stainless steel anode much closer to the mercury cathode than the wall which inhibits arc transfer to the wall. The ignitor is on the centerline supported by a bushing through the anode. Vacuum is maintained by a vacuum system. With an anode-cathode spacing of 6 mm and 850 kA the voltage drop is about 100 volts; with a spacing of 12 mm and 925 kA it increases to 140 volts. These values are a fraction of conventional tubes. The voltage waveform is quite reproducible and free from the usual noise transients, especially with the shorter spacing. The high currents also launch mercury jets which broke the insulator. The jets are suppressed by limiting the depth and outer diameter of the mercury pool. 4 refs., 11 figs., 3 tabs.

51449 (UCRL-JC–103598) **Computations of quenching and stability in a CICC [cable-in-conduit conductor] conductor.** Wong, R.L. Lawrence Livermore National Lab., CA (USA). 21 Sep 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900944–6: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000657. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The quenching and stability behavior of forced-flow helium-cooled, cable-in-conduit conductors (CICC) has been analyzed using a new computer program. This computer analysis code was developed for performing general, transient, thermal analyses on CICCs. The program includes the necessary details for the physical properties of all the constituent materials of such conductors, and accurately models the thermo- and fluid-dynamic behavior of the helium coolant starting from a wide range of initial conditions. It has been applied to a study of the stability and quench behavior of several large-scale conductor options being considered for use in the magnet systems of the International Thermonuclear Experimental Reactor (ITER), and the results will be reported here. 3 refs., 14 figs.

51450 (UCRL-JC–104417) **Novel plasma-based frequency upshift methods for short pulse lasers.** Wilks, S.C. (Lawrence Livermore National Lab., CA (USA)); Dawson, J.M.; Mori, W.B. Lawrence Livermore National Lab., CA (USA). 4 Jun 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900264–8: Topical conference on research trends in nonlinear and relativistic effects in plasmas, San Diego, CA (USA), 5-8 Feb 1990). Order Number DE91000411. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We discuss various novel methods of frequency upshifting short ($\leq$ 1 picosecond) pulses of laser light. All of these methods make use of either the sudden creation of a plasma or relativistic plasma waves. The first method discussed is known as photon acceleration. This method makes use of the fact that a laser pulse moving in a plasma can be thought of as a packet of photons, each possessing an effective mass of $m_\gamma = \hbar\omega_{pe}/c^2$ and moving with the group velocity of the laser pulse. These photons experience a force acting on them when in the presence of a gradient in the plasma density. By using a relativistic plasma wave (i.e., a moving density gradient) traveling with the photons, the energy of the photons (thus the frequency) can be continuously increased. We then discuss the sudden creation of a plasma in a region where there exists an electromagnetic wave. This results in a frequency shift of the wave. A similar method is the creation of an ionization front moving near the speed of light, whereby the interaction of this plasma front with an EM wave also results in a frequency upshift of the original wave. 21 refs.

51451 (UCRL-JC–104983) **Calculation of soft x-ray lasers at 44.8Å and 43.1Å.** Maxon, S. (Lawrence Livermore National Lab., CA (USA)); MacGowan, B.; Dalhed, S.; London, R.A.; Rosen, M.D.; Hagelstein, P.L.; Busch, B.; Charatis, G. Lawrence Livermore National Lab., CA (USA). [1990]. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009266–1-Vugraphs: 2. international colloquium on x-ray lasers, York (UK), 17-21 Sep 1990). Order Number DE91000818. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report contains viewgraphs of results of calculations on soft x-ray lasers. Ionization, spectral lines, shapes, and energy-level transitions are some of the calculations made. (LSP)

51452 High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. 105p. Optical Society of America, Washington, DC (USA) (1989). (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The subject of this book is high energy density physics with subpicosecond laser pulses. The papers presented include: Laser electron studies of nonlinear QED and Performance of high power KrF laser system.

51453 High power lasers and laser machining technology: Volume 1132. Gaillard, M.L. (Lab. de Photophysique, Moleculaire, Orsay (FR)); Quenzel, A. 298p. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8904242–: OPTO '89: international congress on optical science and engineering, Paris (France), 24-28 Apr 1989).

This book reports on research taking place in Europe, the Soviet Union, Japan, and the U.S. that continues the development of efficient laser devices operating on an increasing number of wavelengths. Sessions on laser machining technology describe applications in welding, melting, vaporization, and surface treatment of materials, and these papers detail some of the latest techniques being employed in a variety of situations.

51454 Enhancement of CW alexandrite laser performance. Bonanno, R.E. (Lawrence Livermore National Lab., CA (USA)); Harter, D.J.; Montoya, O. pp. 98-100 of Proceedings of the OSA on tunable solid state lasers: Volume 5. Shand, M.L.; Jenssen, H.P. Optical Society of America, Washington, DC (USA) (1989). pp. 417 (CONF-890432–: American Physical Society meeting, St. Louis, MO (USA), 20-24 Apr 1989).

CW alexandrite laser technology, as compared to pulsed alexandrite laser technology, is still in its infancy. The parameter most germane to cw operation is the stimulated emission cross section-upper state lifetime product (0.7×10^{-20} cm^2 $\times$ 262 μsec), which is 50-100 times smaller than in Nd:YAG, and roughly the same as in Ti:Sapphire. The low emission cross section and concomitant low gain make lamp-pumped cw operation of alexandrite challenging. In this paper the authors report on three areas of research: pump reflector design, rod quality characterization, and optical resonator design, which have led to improved performance of cw alexandrite lasers.

51455 Recent experiments at the Los Alamos free electron laser. Feldman, D.W. (Los Alamos National Lab., NM (USA)). pp. 36-53 of Free-electron lasers 2: Volume 1133. Petroff, Y. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 119 (CONF-8904242–: OPTO '89: international congress on optical science and engineering, Paris (France), 24-28 Apr 1989).

Improvements in the operational characteristics of the Los Alamos free-electron laser have produced experimental results in reasonable agreement with theory and simulation. These experiments include suppressing sidebands by dispersive elements and cavity-length detuning, achieving higher extraction efficiencies, demonstrating deceleration of electrons in the bucket of a tapered wiggler, using a prebuncher at highpower, lasing with a highly tapered wiggler, determining harmonic content, and observing harmonic lasing. The results of these experiments are described.

51456 Modeling of induction-linac based free-electron laser amplifiers. Jong, R.A. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (US)); Fawley, W.M.; Scharlemann, E.T. pp. 18-27 of Modeling and simulation of laser systems: Volume 1045. Bullock, D.L. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 219 (CONF-890154–: Modeling and simulation of laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

The authors describe the modeling of an induction-linac based free-electron laser (IFEL) amplifier for producing multimegawatt levels of microwave power. The authors have used the Lawrence Livermore National Laboratory (LLNL) free-electron laser simulation code, FRED, and the simulation code for sideband calculations, GINGER for this study. For IFEL amplifiers in the frequency range of interest (200 to 600 GHz), they have devised a wiggler design strategy which incorporates a tapering algorithm that is suitable for free-electron laser (FEL) systems with moderate space-charge effects and that minimizes spontaneous noise growth at frequencies below the fundamental, while enhancing the growth of the signal at the fundamental. In addition, engineering design considerations of the waveguide wall loading and electron beam fill factor in the waveguide set limits on the waveguide dimensions, the wiggler magnet gap spacing, the wiggler period, and the minimum magnetic field strength in the tapered region of the wiggler magnet gap spacing, the wiggler period, and the minimum magnetic field strength in the tapered region of the wiggler. As an example, the authors describe an FEL amplifier designed to produce an average power of about 10 MW at a frequency of 280 GHz to be used for electron cyclotron resonance heating of tokamak fusion devices.

51457 Simulation codes for modeling free-electron laser oscillators. Schmitt, M.J. (Mission Research Corp., Los Alamos, NM (US)); Goldstein, J.C.; McVey, B.D.; Tokar, R.L.; Elliott, C.J.; Carlsten, B.E.; Thode, L.E. pp. 28-35 of Modeling and simulation of laser systems: Volume 1045. Bullock, D.L. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 219

(CONF-890154–: Modeling and simulation of laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

This paper reviews the basic characteristics of free-electron laser (FEL) oscillators and describes a group of codes that have been developed to analyze and design rf-linac-driven FELs. The optical performance of an FEL has been treated using 1-D time-dependent (finite pulse)codes that describe the characteristics of the optical temporal pulse shape and spectrum during the evolution of the oscillator from low-intensity small-signal gain conditions to high-intensity large-signal gain conditions. These codes can include frequency-dependent elements, such as narrow-band filters or grating rhombs. Diffraction effects, transverse optical and electron-beam mode properties, misalignments, as well as aberrations on optical elements are modeled with the 3-D code FELEX. This code has now been extended to include the effects of imperfections in the wiggler magnetic field and light emission at higher optical harmonics. A separate accelerator modeling capability allows the use of a numerically-generated electron pulse in FELEX for 3-D integrated numerical FEL simulations.

51458 Plasma generation for recombination x-ray lasers. Pert, G.J. (York Univ. (UK). Dept. of Physics). pp. 69 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The general principles of scaling recombination laws to short wavelength are reviewed. Particular emphasis is given to the role of pulse length in determining gain. The trapping problem is discussed.

51459 Surface-emitting lasers with periodic gain. Corzine, S.W. (Univ. of California, Santa Barbara, CA (US)); Geels, R.S.; Scott, J.W.; Coldren, L.A.; Gourley, P.L. pp. 5-7 of Laser and Electro-Optics Society annual meeting conference proceedings. IEEE Service Center, Piscataway, NJ (USA) (1988). pp. 502 (CONF-8811328–: LEOS '88: Lasers and Electro-Optics Society annual meeting, Santa Clara, CA (USA), 2-4 Nov 1988).

The authors present the concept of periodic gain in the design of Fabry-Perot surface-emitting lasers. They analyze and compare their new periodic gain configuration with two typical standard Fabry-Perot structures and show that significant advantages can be obtained. Aside from the inherent mode selectivity obtained with periodic gain, the authors find that the threshold current can be reduced by a factor of two over standard structures for reasonable ranges of mirror reflectivities.

51460 Wavelength-resonant, surface-emitting semiconductor laser: A novel quantum optical structure. Raja, M.Y.A. (Univ. of New Mexico, Albuquerque, NM (US)); Brueck, S.R.J.; Osinski, M.; Schaus, C.F.; McInerney, J.G.; Brennan, N.M.; Brennan, T.M.; Hammons, B.E. pp. 8-10 of Laser and Electro-Optics Society annual meeting conference proceedings. IEEE Service Center, Piscataway, NJ (USA) (1988). pp. 502 (CONF-8811328–: LEOS '88: Lasers and Electro-Optics Society annual meeting, Santa Clara, CA (USA), 2-4 Nov 1988).

The authors designed, fabricated and demonstrated lasing action in a novel vertical surface-emitting laser structure. The MBE-grown structure is a series of 10-nm thick GaAs quantum wells separated by 120-nm thick AlGaAs barriers for a spatially periodic gain medium resonant with the lasing wavelength. Lasing has been achieved by optical pumping with a gain length of only 320 nm.

51461 High-energy helium backscattering for the compositional analysis of thin-film oxide-superconductors. Hubbard, K.M. (Los Alamos National Lab., Albuquerque, NM (US)); Martin, J.A.; Muenchausen, R.E.; Tesmer, J.R.; Nastasi, M. pp. 165-174 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

Recent experiments have demonstrated that the broad elastic-scattering resonance for 8.8 MeV helium bombardment of oxygen can be exploited to measure the oxygen content of YBaCuO thin films. A potential difficulty with such measurements is distortion of the backscattering spectrum due to resonant scattering from the substrate elements, which could prevent the accurate integration of peak areas. The authors have measured the elastic scattering cross sections for Sr and Ti, relative to Gd, with He ions in the energy range of 2.2-8.8 MeV, and a scattering angle of 165°. The results verify that resonant scattering from the substrate does not interfere with the high-energy compositional analysis of YBaCuO films deposited on $SrTiO_3$.

51462 Intracavity second-harmonic generation in an alexandrite unidirectional ring laser. Band, Y.B. (Ben-Gurion Univ. of the Negev, Beersheba (Israel)); Acherhalt, J.R.; Chin, T.; Krasinski, J.S.; Papanestor, P. pp. 101-102 of Proceedings of the OSA on tunable solid state lasers: Volume 5. Shand, M.L.; Jenssen, H.P. Optical Society of America, Washington, DC (USA) (1989). pp. 417 (CONF-890432–: American Physical Society meeting, St. Louis, MO (USA), 20-24 Apr 1989).

Second harmonic conversion (SHG) of Alexandrite is an effective means of obtaining tunable high peak power over the wavelength range 350-400nm. However, external SHG requires high intensity for efficient conversion and optical damage problems can result. An alternative is to utilize high intracavity intensities for conversion while at the same time use the SHG process as a power limiter for the intracavity fundamental laser beam. Intracavity SHG in a unidirectional Alexandrite ring laser with the only output at the second harmonic frequency was studied. Experimental results and their comparison with modeling studies of such a process are discussed.

51463 Amplified spontaneous emission effects in laser amplifiers. Chow, W.W. (Division 2531, Sandia National Lab., Albuquerque, NM (US)). pp. 139-149 of Modeling and simulation of laser systems: Volume 1045. Bullock, D.L. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 219 (CONF-890154–: Modeling and simulation of laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

The authors investigate the effects of amplified spontaneous emission on laser amplifier performance. In particular, they are interested in the dependence of gain, signal to noise ratio and efficiency on excitation, facet reflectivity and input laser intensity.

51464 Efficient, scalable, four wave mixing for tunable VUV generation. Lowenthal, D.D. (Spectra Technology, Inc., Bellevue, WA (US)); Muller, C.H. III; Hamilton, C.; Smith, A.V. pp. 194-198 of Lasers and Electro-Optics Society annual meeting conference proceedings. Streifer, W.; Shumate, P.W.; Smith, P.W. IEEE Service Center, Piscataway, NJ (USA) (1988). pp. 502 (CONF-8811328–: LEOS '88: Lasers and Electro-Optics Society annual meeting, Santa Clara, CA (USA), 2-4 Nov 1988).

Over 1.0 mJ of tunable, coherent, vacuum ultraviolet (VUV) light at 130 nm has been produced by resonant sum-frequency mixing in mercury vapor. By using three colinear, unfocused beams (at wavelengths of 777, 405, and 255 nm), mixing efficiencies of up to 6.0 percent have been demonstrated. Because unfocused beams are employed the process is an area scalable to much higher total energies. A summary of experimental results and a description of an all solid state laser approach to generate VUV is presented.

51465 Generation of high peak power Fourier-transform limited light pulses near 200nm using beta barium borate. Glab, W.L. (Argonne National Lab., Argonne, IL (US)). pp. 190-193 of Lasers and Electro-Optics Society annual meeting conference proceedings. Streifer, W.; Shumate, P.W.; Smith, P.W. IEEE Service Center, Piscataway, NJ (USA) (1988). pp. 502 (CONF-8811328–: LEOS '88: Lasers and Electro-Optics Society annual meeting, Santa Clara, CA (USA), 2-4 Nov 1988).

The authors have generated the third harmonic of light from a CW ring dye laser after pulsed amplification in a dye amplifier chain pumped by an injection seeded Nd^{+3}:YAG laser. The 5 mJ/pulse output was temporally smooth, tunable between 204 and 197.4 nm, with a transform limited bandwidth of ~120 MHz.

51466 High gain 10.6-micron free-electron laser amplifier. Miller, J.L. (Lawrence Livermore National Lab., Livermore, CA

(US)); Chambers, F.W.; Chong, Y.P.; Edighoffer, J.A.; Orzechowski, T.J.; Prosnitz, D.; Scharlemann, E.T.; Halbach, K. pp. 349-352 of Lasers and Electro-Optics Society annual meeting conference proceedings. Streifer, W.; Shumate, P.W.; Smith, P.W. IEEE Service Center, Piscataway, NJ (USA) (1988). pp. 502 (CONF-8811328–: LEOS '88: Lasers and Electro-Optics Society annual meeting, Santa Clara, CA (USA), 2-4 Nov 1988).

A 10.6-micron wavelength free-electron laser (FEL) amplifier has been operated using a 45-MeV, 600-A electron beam from the Advanced Test Accelerator (ATA) and a 15.36-meter long electromagnetic wiggler. The peak small signal power gain was 27 dB(500). Gain guiding was observed to confine the amplified laser beam.

51467 The characterization of organic-charge transfer Superconductors by microreflectance spectroscopy. Ferraro, J.R. (Argonne Natinal Lab., Dept. of Chemistry, Argonne, IL (US)); Hill, S.L.; Krishnan, K. pp. 491-493 of Proceedings of the 7th international conference on Fourier transform spectroscopy: Volume 1145. Cameron, D.G. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 642 (CONF-890674–: 7. international conference on Fourier transform spectroscopy, Fairfax, VA (USA), 19-23 Jun 1989).

Certain classes of organic charge-transfer salts demonstrate superconducting behavior at liquid helium temperatures. Single crystal x-ray diffraction and microreflectance FT-IR analysis have been performed on several conducting systems to deduce the nature of the crystalline structure which affect the electrical conductivity. The infrared spectrum for a single crystal salt exhibits absorptions form the unsaturated organic salt as well as influences form the electronic transitions. There are strong correlations between particular absorption profiles and the single crystal conductivity. Routine examination of the long-term stability of the morphology as well as contamination of the single crystal may be studied.

51468 Self-compression of the multilayer insulation around the horizontal cylindrical shield. Ohmori, T. (Fermi National Accelerator Lab., Batavia, IL (US)); Niemann, R.C. pp. 455-460 of New developments in applied superconductivity. Murakami, Y. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 807 (CONF-8810245–: International symposium on new developments in applied superconductivity, Suita (Japan), 17-19 Oct 1988).

Multilayer insulation (MLI) installed around the horizontal cylindrical shield in the superconducting magnet cryostat is compressed at the upper part of the shield due to the MLI weight. Pressure distribution in the MLI is analyzed around the shield, and is related to the shield size and the specific weight of the MLI. The cross section of MLI has been examined with a single plastic film around a horizontal cylinder and compared to the result of the analysis. Thermal performance of four kinds of MLI are related to the normalized compressive pressure by the specific weight of the MLI to discuss the degradation of the performance by compression.

51469 Channel-width tailoring of index-guided arrays. Hadley, G.R. (Sandia National Lab., Albuquerque, NM (US)); Buus, J. pp. 488-490 of Lasers and Electro-Optics Society annual meeting conference proceedings. Streifer, W.; Shumate, P.W.; Smith, P.W. IEEE Service Center, Piscataway, NJ (USA) (1988). pp. 502 (CONF-8811328–: LEOS '88: Lasers and Electro-Optics Society annual meeting, Santa Clara, CA (USA), 2-4 Nov 1988).

The authors propose individually tailored channel widths for index-guided arrays. They compensate for thermal effects and provide fundamental mode operation at currents up to twice threshold.

51470 Optically pumped fir lasers. De Temple, T.A. pp. 495-572 of Handbook of molecular lasers. Cheo, P.K. Marcel Dekker Inc., New York, NY (USA) (1987). pp. 648

This paper reviews the characteristics of optically pumped mid-infrared and far-infrared lasers to the basic light-matter and kinetic interactions present in these systems, as opposed to detailed design rules. Current activities at the research level are described. Industrial applications are addressed.

51471 Design of high-average-power near-millimeter free electron laser oscillators using short-period wigglers and sheet electron beams. Booske, J.H. (Wisconsin Univ., Madison, WI (USA). Dept. of Electrical and Computer Engineering); Radack, D.J.; Antonsen, T.M.; Bidwell, S.W.; Carmel, Y.; Destler, W.W.; Granatstein, V.L.; Latham, P.E.; Levush, B.; Mayergonoz, I.D.; Serbeto, A. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 99-415 (Jun 1990).

The design and feasibility of a 1-MW continuous wave (CW) free electron laser (FEL) oscillator are reviewed. The proposed configuration will include a short-period planar wiggler, a sheet electron beam, a 0.5–1.0 MV thermionic electron gun, a hybrid waveguide/quasi-optical resonator, commercial dc power supplies, and a depressed collector. Cavity ohmic RF losses are estimated to be extremely low ($\lesssim$ 10–100 W/cm^2) at 1-MW output power, while thermal heat transfer studies conservatively indicate that wall cooling up to 1500 W/cm^2 should be possible.

51472 Fabricating polycrystalline high-T_c superconductors. Lanagan, M.T. (Argonne National Lab., IL (USA)); Dorris, S.E.; Singh, J.P.; Goretta, K.C.; Balachandran, U.; Youngdahl, C.A.; Dusek, J.T.; Picciolo, J.J.; Poeppel, R.B. *JOM (1989) (USA),* 42(6): 16-18 (Jun 1990). DOE Contract W-31-109-ENG-38.

Many applications of high-temperature superconductors require the ability to carry large currents in high magnetic fields. Electrical properties of single crystals and thin films offer hope that suitable electrical properties will be obtained in polycrystalline materials. Novel microstructures can be produced by melt-recrystallization processes that can be characterized by oriented crystallites. The large critical current densities required for many applications have been demonstrated by powder-in-tube and melt-texturing processes to form bulk polycrystalline materials. Plastic forming techniques, such as extrusion and tape casting, offer the advantage of fabricating long and continuous coils. Near-term products that operate in low magnetic fields include current leads, shielding devices and high-quality resonant cavities.

51473 A metallurgical approach to high-T_c microcomposites. 0Gao, W. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering); Rudman, D.A.; VanderSande, J.B. *JOM (1989) (USA),* 42(6): 19-22 (Jun 1990).

Since the discoveries of high-T_c superconducting oxides in the La-Ba-Cu-O system, the Y-Ba-Cu-O system, the Bi-Sr-Ca-Cu-O system and the Tl-Ba-Ca-Cu-O system, tremendous efforts have been made in the synthesis, processing and characterization of these materials in an effort to move toward applications. One of the methods for the synthesis of bulk superconducting oxides is high-temperature oxidation of metallic precursor alloys. Noble metals (e.g., silver) can be added to these alloys to produce microcomposites and improve mechanical properties. The content of the noble metals can be adjusted to alter the mechanical as well as superconducting properties of the products. Compared with conventional ceramic processes, the precursor oxidation method produces superconducting materials with variable shapes, high density and improved mechanical properties. The metallic precursor method can also provide joints between two superconductors or superconductors and normal metals.

51474 Mode competition and control in high-power gyrotron oscillators. Levush, B. (Maryland Univ., College Park, MD (USA). Lab. for Plasma Research); Antonsen, T.M. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 260-272 (Jun 1990).

One of the problems in the design of high-power millimeter wave sources such as gyrotron oscillators is insuring that the device operates in the desired mode. For high-power and short-wavelength devices the effective mode density is high, in that the current is above threshold for many modes. One then is led to ask the following questions: Is operation in a single mode possible? What steps must be taken to maximize the electronic efficiency of the device while ensuring single-mode operation? The answer to the first question has been determined to be yes. Provided that certain conditions are met, single-mode operation is stable. However, for a given set of parameters there are many modes that are potentially the stable operating mode. This paper then attempts to address the second question regarding control of the operating mode.

51475 AC space-charge effects in gyroklystron amplifiers. Latham, P.E. (Maryland Univ., College Park, MD (USA). Lab. for Plasma Research). *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 273-285 (Jun 1990).

When ac space charge is included in the analysis of weakly relativistic multicavity gyroklystron amplifiers, the optimized nonlinear efficiency becomes a function of beam current. For a cold beam (no velocity spread), the efficiency is maximum at zero current and decreases monotonically as the current increases. The zero current limit of the optimized efficiency when ac space-charge effects are included is *not* the same as the optimized efficiency with no space charge; it is significantly higher. This rather strange behavior is regularized when velocity spread is taken into account; in that case, the nonlinear efficiency increases with beam current until it reaches a maximum, then falls off slowly. The increase in the efficiency is attributed to enhanced bunching associated with the saturation of the space-charge instability in the drift region; the reduction in efficiency at high current occurs because space charge induces an additional velocity spread in the beam.

51476 Pulse shapes for absolute and convective cyclotron-resonance-maser instabilities. Davies, J.A. (Clark Univ., Worcester, MA (USA). Dept. of Physics); Davidson, R.C.; Johnston, G.L. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 286-300 (Jun 1990).

A linear analysis is presented for pulse shapes produced by a spatial and temporal delta-function disturbance of cyclotron-resonance-maser modes for the case where the initial equilibrium state is free of radiation. A pinch-point analysis based on the theory of Briggs and Bers is employed. Numerical and analytical techniques are developed for the straightforward calculation of pinch-point coordinates in a reference frame moving with arbitrary velocity in the axial direction. Examples analyzed include the absolute instability in the waveguide operating mode, in higher harmonics of the operating mode, and in lower-frequency waveguide modes when the operating mode is a higher-order waveguide mode. Effects of waveguide wall resistance on pulse shapes and the effectiveness of such resistance in suppressing or reducing the growth rates of absolute instabilities are also analyzed.

51477 Demonstration of x-ray amplifiers near the carbon *K* edge. MacGowan, B.J. (Lawrence Livermore National Laboratory, University of California, P.O. Box 5508, Livermore, CA (USA)); Maxon, S.; Da Silva, L.B.; Fields, D.J.; Keane, C.J.; Matthews, D.L.; Osterheld, A.L.; Scofield, J.H.; Shimkaveg, G.; Stone, G.F. *Physical Review Letters (USA),* 65(4): 420-423 (23 Jul 1990). DOE Contract W-7405-ENG-48.

The Ni-like 4*d*-4*p* laser scheme has been extended to wavelengths near the *K* absorption edge of carbon. A gain of 2.3 cm^{-1} with a duration of 250 psec was observed in Ni-like Ta at 44.83 A (a wavelength close to optimal for holographic imaging of live cells). Ni-like W produced a gain of 2.6 cm^{-1} with a total of seven gainlengths of amplification at 43.18 A. This is the first demonstration of an x-ray amplifier on the short-wavelength side of the carbon *K* edge, within the "water window." Both lasers should be scalable to coherent power sufficient for holographic imaging and other applications.

51478 Highly stable strained layer leaky-mode diode laser arrays. Shiau, T.H. (New Mexico Univ., Albuquerque, NM (USA). Center for High Technology Materials); Sun, S.; Schaus, C.F.; Zheng, K.; Hadley, G.R. *IEEE Photonics Technology Letters (Institute of Electrical and Electronics Engineers) (USA),* 2(8): 534-536 (Aug 1990). DOE Contract AC04-76DP00789.

A simple new fabrication process for InGaAs strained quantum well leaky-mode laser arrays is demonstrated. The arrays are ten-element devices grown by two-step metal-organic chemical vapor deposition. The structure consists of a strained quantum well InGaAs graded index-separate confinement active region and a thin (0.12 μm), transparent GaAs waveguide region. The near-field pattern typical of leaky-mode phase-locked arrays is measured. Fundamental mode oscillation is observed up to 2 A (threshold is as low as 174 mA). A 1 μs pulsed optical output power of 172 mW per facet and far-field angle (FWHM) of 1.6 times the diffraction limit is observed at 1 A. This is the first reported operation of a strained quantum well leaky-mode laser utilizing a built-in index step.

51479 Tests of a superconducting rf quadrupole device. Delayen, J.R. (Engineering Physics Division, Argonne National Laboratory, Argonne, IL (USA)); Shepard, K.W. *Applied Physics Letters (USA),* 57(5): 514-516 (30 Jul 1990). DOE Contract W-31109-ENG-38.

High surface electric fields have been obtained in the first tests of a superconducting rf quadrupole device. The rf quadrupole fields were generated between niobium vanes 6.5 cm in length, with an edge radius of 2 mm, and with a beam aperture of 6 mm diameter. In tests at 4.2 K, the 64 MHz device operated cw at peak surface electric fields of 128 MV/m. Virtually no electron loading was observed at fields below 100 MV/m. It was possible to operate at surface fields of 210 MV/m in pulses of 1 ms duration using a 2.5 kW rf source. For the vane geometry tested, more than 10 square centimeters of surface support a field greater than 90% of the peak field. The present result indicates that electric fields greater than 100 MV/m can be obtained over an appreciable area, sufficient for some accelerator applications. It also shows that superconducting rf technology may provide an extended range of options for rf quadrupole design.

51480 Modal analysis of x-ray laser coherence. London, R.A. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Strauss, M.; Rosen, M.D. *Physical Review Letters (USA),* 65(5): 563-566 (30 Jul 1990). DOE Contract W-7405-ENG-48.

We present a modal analysis of the paraxial wave equation for plasma x-ray lasers. Gain guiding and refractive antiguiding are identified as the essential mechanisms which influence the coherence of the output radiation. Scaling laws for the number of guided modes and the coherence are given, depending on three parameters: the gain-dependent Fresnel number, the strength of refraction relative to gain, and the amplification length. The importance of controlling excess spontaneous emission to obtain coherence is identified. We suggest an experimental effort to verify various guiding regimes and to produce coherent output in the range between 45 and 200 A.

51481 8.5 MW GaAs pulse biased switch optically controlled by 2-D laser diode arrays. Rosen, A. (David Sarnoff Research Center, Princeton, NJ (US)); Stabile, P.J.; Zutavern, F.J.; Loubriel, G.M.; Helgeson, W.D.; O'Malley, M.W.; McLaughlin, D.L. *IEEE Photonics Technology Letters (Institute of Electrical and Electronics Engineers) (USA),* 2(7): 525-526 (Jul 1990).

This paper describes the development of a compact, all solid-state switch system that has switched up to 8.5 MW into a 38 Ω load. The system uses a 2-D laser diode array with a peak power of 850 W to trigger a 1.5 cm long GaAs photoconductor into a high-gain conduction mode known as lock on. The highest power switch was pulse-charged to 55 kV and delivered 470 A to a 38 Ω in a 160 ns long pulse.

51482 Magnetic alignment and the Poisson alignment reference system. Griffith, L.V. (Lawrence Livermore National Laboratory, University of California, Livermore, CA (USA)); Schenz, R.F.; Sommargren, G.E. *Review of Scientific Instruments (USA),* 61(8): 2138-2154 (Aug 1990). DOE Contract W-7405-ENG-48.

Three distinct metrological operations are necessary to align a free-electron laser (FEL): the magnetic axis must be located, a straight line reference (SLR) must be generated, and the magnetic axis must be related to the SLR. This article begins with a review of the motivation for developing an alignment system that will assure better than 100-μm accuracy in the alignment of the magnetic axis throughout an FEL. The 100-μm accuracy is an error circle about an ideal axis for 300 m or more. The article describes techniques for identifying the magnetic axes of solenoids, quadrupoles, and wiggler poles. Propagation of a laser beam is described to the extent of revealing sources of nonlinearity in the beam. Development of a straight-line reference based on the Poisson line, a diffraction effect, is described in detail. Spheres in a large-diameter laser beam create Poisson lines and thus provide a necessary mechanism for gauging between the magnetic axis and the SLR.

Procedures for installing FEL components and calibrating alignment fiducials to the magnetic axes of the components are also described. The Poisson alignment reference system should be accurate to 25 μm over 300 m, which is believed to be a factor-of-4 improvement over earlier techniques. An error budget shows that only 25% of the total budgeted tolerance is used for the alignment reference system, so the remaining tolerances should fall within the allowable range for FEL alignment.

51483 Apparatus for measurement of surface resistance versus rf magnetic field of high-$T_c$superconductors. Delayen, J.R. (Argonne National Laboratory, Engineering Physics Division, 9700 South Cass Avenue, Argonne, IL (USA)); Bohn, C.L.; Roche, C.T. *Review of Scientific Instruments (USA)*, 61(8): 2207-2210 (Aug 1990). DOE Contract W-31109-ENG-38.

A coaxial niobium quarter-wave resonant cavity has been fabricated and used for measurement of the surface resistance of disk-shaped samples of high-$T_c$superconductors at 820 MHz and 4.2 K, and at surface rf magnetic fields ranging to 300 G. The cavity can accommodate samples as large as 36 mm in diameter. A measurement procedure has been developed with which rf surface resistances less than 20 $\mu\Omega$ can be resolved for a 24-mm-diam sample at 820 MHz. This cavity is useful in determining the suitability of high-T_c superconductors for high-power rf applications.

51484 Heterodyne laser instantaneous frequency measurement system. Wyeth, R.W.; Johnson, M.A.; Globig, M.A. To Dept. of Energy, Washington, DC (USA). USA Patent 4,940,331/A/. 10 Jul 1990. Filed date 27 Sep 1988. USA Patent patents application 7-249,816. Int. Cl. G01B 9/02. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a laser beam frequency diagnostic system. It comprises: a first pulsed laser for generating a first short time duration pulsed laser beam having a pulse length duration of approximately 10–100 nanoseconds, the instantaneous frequency of which is to be determined, a second reference laser for generating a second laser beam having a predetermined frequency, means for heterodyning the first and second laser beams to form a beat signal representative of the difference between the first and second frequencies, and means for processing the beat signal with respect to time to determine the instantaneous frequency of the first laser beam.

51485 Neutron-driven gamma-ray laser. Bowman, C.D. To Dept. of Energy, Washington, DC (USA). USA Patent 4,939,742/A/. 3 Jul 1990. Filed date 28 Mar 1989. USA Patent patents application 7-329,710. Int. Cl. H01S 3/30. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This paper describes a gamma-ray laser rod emitting a radiation beam of gamma-ray wavelength when excited with a neutron flux. It comprises: a lasing cylinder having a rolled foil material as a support structure; a first nuclear species deposited on both sides of the foil, the first nuclear species interacting with the neutron flux for transition to a second nuclear species by a particle emission effective to impart a recoil velocity to atoms of the second nuclear species for separating the second nuclear species from the first nuclear species, the second nuclear species being formed from the first nuclear species in an excited state generating a population inversion with a ground state for spontaneous emission at the gamma-ray wavelength; a high Debye temperature host material, binding the second species for recoilless Mossbauer emissions from the excited state of the second nuclear species, deposited on one of the deposits of the first nuclear species; the first nuclear species being deposited to a first thickness enabling the recoil velocity to separate the second nuclear species from the first nuclear species and into the host material; the host material being deposited to a second thickness to stop the second nuclear species with the recoil velocity for the binding the second nuclear species for the Mossbauer emission from the second nuclear species at the gamma-ray wavelength, thereby producing an amplified spontaneous emission device for producing a gamma-ray wavelength.

51486 Arrangement for multiplexing and intensity splitting light beams for interface into fiber optic cables. Johnson, S.A. To Dept. of Energy, Washington, DC (USA). USA Patent 4,933,949/A/. 12 Jun 1990. Filed date 28 Mar 1989. USA Patent patents application 7-329,721. Int. Cl. H01S 3/20. vp. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes an arrangement for converting different input light beams into substantially identical output light beams. It comprises: an optical mixing bar including a main body for mixing light therein, an input face on one end of the main body, and a multi-faceted output face on an opposite end of the main body whereby light entering the main body from the input face is mixed therein and exists the output face as mixed output light beams corresponding in number to the number of facets making up the output face, and means for directing the plurality of different input light beams onto the input face of the mixing bar, whereby to cause the different beams to mix within the main body of the mixing bar and exit the latter from its multi-faceted output face as the mixed output beams.

51487 Semiconductor heterojunction device with graded bandgap. Chu, T.K. To Department of the Navy, Washington, DC. USA Patent Application 7-517,013. 27 Apr 1990. 9p. Source: NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This invention relates generally to rectifying junction types of semiconductor devices and more particularly to a heterojunction structure with a graded gap region at its interface. Semiconductor rectifying junction devices are widely utilized in electronic and electro-optic installations, including by way of example infrared photovoltaic detectors. The most commonly utilized semiconductor devices are of the p-n junction and Schottky junction types. In the p-n junction device, p-type and n-type classes of materials are deposited on each other and arranged to minimize migration of dopants across the junction.

51488 Thulium-doped fluorozirconate fiber laser pumped by a diode laser source. Allen, R.; Esterowitz, L. To Department of the Navy, Washington, DC. USA Patent Application 7-486,638. 28 Feb 1990. 15p. Source: NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The present invention relates to lasers and particularly to a diode-pumped, fiber laser doped with thulium activator ions for producing an output CW laser emission at a wavelength of substantially 2.3 microns. In low power applications, such as in telecommunications and in medical and sensing applications, the use of fiber lasers is becoming more and more important. In a typical fiber laser a rare earth, such as erbium, neodymium, terbium or praseodymium, is doped into the core of an optical fiber to provide an active gain medium for the fiber laser. Typically, the optical fiber is comprised of silica.

51489 Room-temperature, flash-pumped, 1.96-micron solid-state laser. Quarles, G.; Stoneman, R.; Esterowitz, L.; Marquardt, C. To Department of the Navy, Washington, DC. USA Patent Application 7-459,211. 29 Dec 1989. 22p. Source: NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This patent application is related to the co-pending United States patent application entitled A Room-Temperature, Flashpumped, 2 Micron Solid State Laser With High Slope Efficiency, Serial No. (Navy Case No. 72, 360), filed December 22, 1989, both of which applications being commonly assigned to the Government of the United States. The present invention relates to lasers and particularly to a flashpumped solid state laser which operates at a wavelength of 1.96 microns at or near room temperature.

43 PARTICLE ACCELERATORS

51490 (UCRL-ID–103289) **Potential for collaboration on the Superconducting Super Collider.** Tarter, C.B. Lawrence Livermore National Lab., CA (USA). Mar 1990. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order

Number DE91000485. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The viewgraphs on the following pages comprise a presentation to the L_3/L_- collaboration as a basis for Livermore's participation. First we give an overview of the Laboratory mission, budget, and staff. Next, some illustrative examples of laser fusion, laser isotope, and beam research/magnetic fusion are shown. Finally, we show a few cases of current research that is relevant to high energy physics.

4301 Design, Development, and Operation

Refer also to citation(s) 51638

51491 (BNL–45171) **The Brookhaven National Laboratory (BNL) Accelerator Test Facility.** Batchelor, K. Brookhaven National Lab., Upton, NY (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9009123–24: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000577. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The design of the Brookhaven National Laboratory Accelerator Test Facility is presented including the design goals and computational results. The heart of the system is a radiofrequency electron gun utilizing a photo-excited metal cathode followed by a conventional electron linac. The Nd:YAG laser used to drive the cathode with 6 ps long pulses can be synchronized to a high peak power CO_2 laser in order to study laser acceleration of electrons. Current operational status of the project will be presented along with early beam tests.

51492 (LA-UR–90-2932) **Lasing on higher harmonics.** Warren, R.W. Los Alamos National Lab., NM (USA). [1990]. 12p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009166–4: 12. international free electron laser conference (FEL-12), Paris (France), 17-21 Sep 1990). Order Number DE91000448. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lasing at short wavelengths with an accelerator of modest energy can only be achieved with a wiggler of short period and high field operating, perhaps, at a high harmonic of the fundamental frequency. We discuss the characteristics of wigglers of this kind, designed to lase with harmonic numbers as large as fifty or so, emphasizing their gain, efficiency, and sensitivity to emittance and energy spread. 5 refs., 3 figs.

51493 (LA-UR–90-3082) **The pros and cons of cryogenic accelerators: An engineering point of view.** Fox, W.E. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009123–19: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000246. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The design of cryogenic linacs is a challenging engineering task; however, significant improvements in accelerator performance are possible. Resistive power losses may be reduced by a factor of four or greater. Greater flexibility is possible in thermal management as a result of substantial increases in thermal conductivity for certain materials. Radio frequency structures may be an order of magnitude more stable in terms of frequency shifts due to thermal transients resulting from very small coefficients of thermal expansion at cryogenic temperatures. Significant engineering problems must be addressed, such as the design of effective rf contacts that will not be affected by thermal cycling and the design of cryogenic mechanisms and dynamic components, such as frequency tuners, that operate reliably at cryogenic operating temperatures. The areas of high-power sparking and multipactoring have not yet been experimentally addressed. Both Los Alamos, Grumman Aerospace Corporation, and Boeing Corporation have built or are building and testing cryogenic accelerator structures. This paper will review the advances made in cryogenic technology applied to radio frequency quadrupole (RFQ) and drift tube linac (DTL) structures and will discuss the advantages and engineering challenges that these linacs present.

51494 (LA-UR–90-3096) **Linear accelerator for production of tritium: Physics design challenges.** Wangler, T.P.; Lawrence, G.P.; Bhatia, T.S.; Billen, J.H.; Chan, K.C.D.; Garnett, R.W.; Guy, F.W.; Liska, D.; Nath, S.; Neuschaefer, G.; Shubaly, M. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009123–12: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000242. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In the summer of 1989, a collaboration between Los Alamos National Laboratory and Brookhaven National Laboratory conducted a study to establish a reference design of a facility for accelerator production of tritium (APT). The APT concept is that of a neutron-spallation source, which is based on the use of high-energy protons to bombard lead nuclei, resulting in the production of large quantities of neutrons. Neutrons from the lead are captured by lithium to produce tritium. This paper describes the design of a 1.6-GeV, 250-mA proton cw linear accelerator for APT.

51495 (LA-UR–90-3138) **Three-dimensional simulations of harmonic radiation and harmonic lasing.** Schmitt, M.J.; McVey, B.D. Los Alamos National Lab., NM (USA). [1990]. 17p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009166–5: 12. international free electron laser conference (FEL-12), Paris (France), 17-21 Sep 1990). Order Number DE91000235. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Characteristics of the harmonic emission from free-electron lasers (FELs) are examined in the spontaneous, coherent-spontaneous and stimulated emission regimes. The radiation at both odd and even harmonic frequencies is treated for electron beams with finite emittance and energy spread. In the spontaneous emission regime, the transverse radiation patterns including the transverse frequency dependences, are given. How this expression is modified to include energy spread and emittance is described. In the coherent-spontaneous emission and stimulated emission regimes, the interaction of the radiation fields with the electrons must be treated self-consistently. Here, a single-frequency distributed transverse source function for each electron is used in the harmonic version of the 3-D code FELEX to model the harmonic radiation. The code has recently been modified to simultaneously model the fundamental and harmonic interactions for multiple-pass oscillator simulations. These modifications facilitate the examination of FELs under various operating conditions. When the FEL is lasing at the fundamental, the evolution of the harmonic fields can be examined. This evolution is unique in the sense that the electron beam radiates at the harmonic frequencies in the presence of the harmonic radiation circulating in the cavity. As a result, enhancements of the harmonic emission can be observed. Finally, harmonic lasing can occur in cases where there is sufficient gain to overcome cavity losses and lasing at the fundamental can be suppressed. The characteristics and efficiency of these interactions are explored. 11 refs., 9 figs.

51496 (LA-UR–90-3315) **High power linear accelerators for tritium production and transmutation of nuclear waste.** Lawrence, G.P. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-901116–2: 11. international conference on the application of accelerators in research and industry, Denton, TX (USA), 5-8 Nov 1990). Order Number DE91000187. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Proton linacs driving high-flux spallation neutron sources are being considered for transmutation of nuclear waste and production of tritium. Advances in high-current linac technology have provided a basis for the development of credible designs for the required accelerator, which has a nominal 1.6-GeV energy, and a 250-mA cw current. A beam with these parameters incident on a liquid lead-bismuth (Pb-Bi) target can generate a thermal neutron flux of up to 5×10^{16} n/cm^2-s in a cylindrical blanket surrounding the spallation source. This high flux can produce tritium through the $^6Li(n,\alpha)T$ or $^3He(n,\gamma)T$ reactions, or can burn long-lived actinides and fission products from nuclear waste through capture and fission processes. In some system scenarios, waste actinides and/or other

fissile materials in the blanket can produce sufficient fission energy to power the accelerator.

51497 (LA-UR–90-3322) **New beam facilities at LAMPF.** Boudrie, R.L. Los Alamos National Lab., NM (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9004246–1: Conference on prospects of hadronic physics at low energies, Zuoz (Switzerland), 7-25 Apr 1990). Order Number DE91000185. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Over the last few years several upgrades have been built and commissioned at LAMPF. In addition two new facilities have been proposed. In particular, new facilities exist using the polarized beam, including a new intense optically pumped ion source beam, a neutron time-of-flight facility, and a medium-resolution spectrometer. A superconducting rf buncher cavity is ready for initial use with the low-energy pion beam. A proposal has been accepted to construct a high-resolution, large-acceptance spectrometer for neutral mesons. Planning and design work has begun in detail for a pion linear accelerator to provide intense beams of pions near 1 GeV/c. 5 refs.

51498 (LBL–29114-Extd.Abst.) **New techniques for particle accelerators: Extended abstract.** Sessler, A.M. Lawrence Berkeley Lab., CA (USA). Jun 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900603–37-Extd.Abst.: 2. European particle accelerator conference, Nice (France), 11-16 Jun 1990). Order Number DE91000234. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A review is presented of the new techniques which have been proposed for use in particle accelerators. Attention is focused upon those areas where significant progress has been made in the last two years–in particular, upon two-beam accelerators, wakefield accelerators, and plasma focusers. 26 refs., 5 figs., 1 tab.

51499 (SSCL–310) **The Superconducting Super Collider (SSC) linac.** Watson, J.M. Superconducting Super Collider Lab., Dallas, TX (USA). Sep 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-9009123–34: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000464. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The preliminary design of the 600 MeV H^- linac for the Superconducting Super Collider injector is described. The linac must provide a 25 mA beam during 7–35 μs macropulses at Hz within injection bursts. Normalized transverse emittances of less than 0.5 π mm-mrad (rms) are required for injection into the Low Energy Booster synchrotron. Cost, ease of commissioning, and operational reliability are important considerations. The linac will consists of an H^- source with electrostatic LEBT, 2.5 MeV radiofrequency quadrupole accelerator, a 70 MeV drift-tube linac, and 530 MeV and the side-coupled linac operates at 1284 MHz. A modest total length of 150 m results from the tradeoff between cost optimization and reliability. The expected performance from beam dynamics simulations and the status of the project are described. 11 refs., 1 fig., 6 tabs.

51500 (UCRL-JC–103788) **Design of long induction linacs.** Caporaso, G.J.; Cole, A.G. Lawrence Livermore National Lab., CA (USA). 6 Sep 1990. 7p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. W31RPD-8-D 5005. (CONF-9009123–30: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000659. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A self-consistent design strategy for induction linacs is presented which addresses the issues of brightness preservation against space charge induced emittance growth, minimization of the beam breakup instability and the suppression of beam centroid motion due to chromatic effects (corkscrew) and misaligned focusing elements. A simple steering algorithm is described that widens the effective energy bandwidth of the transport system.

51501 (UCRL-JC–104102) **A 250-GHz CARM [Cyclotron Auto Resonance Maser] oscillator experiment driven by an induction linac.** Caplan, M. (Lawrence Livermore National Lab., CA (USA)); Kulke, B.; Bubp, D.G.; McDermott, D.; Luhmann, N. Lawrence Livermore National Lab., CA (USA). 14 Sep 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009166–6: 12. international free electron laser conference (FEL-12), Paris (France), 17-21 Sep 1990). Order Number DE91000790. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A 250-GHz Cyclotron Auto Resonance Maser (CARM) oscillator has been designed and constructed and will be tested using a 1-kA, 2-MeV electron beam produced by the induction linac at the Accelerator Research Center (ARC) facility of Lawrence Livermore National Laboratory (LLNL). The oscillator circuit was made to operate in the TE_{11} mode at ten times cutoff using waveguide Bragg reflectors to create an external cavity Q of 8000. Theory predicts cavity fill times of less than 30 ns (pulse length) and efficiencies approaching 20% is sufficiently low transverse electron velocity spreads are maintained (2%).

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 51466, 51554, 51565, 51570, 51575

51502 (DOE/ER/40150–131) **A fast optics and orbit correction program.** Bowling, B.; Kewisch, J.; Kloeppel, P.; Rossmanith, R. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. Aug 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-010). Order Number DE91000628. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

CEBAF is a large recirculating linear accelerator with approximately 1600 magnet power supplies in the beam transport system. The average beam power can be as great as 800 kW, concentrated into a spot of area less than 0.01 mm^2. Control of the transport is therefore quite critical, to avoid missteering the beam. To prevent dangerous beam losses and to prepare optics changes, the control programs must read the magnet power supplies and calculate the optics in a virtually real-time manner. A program named OLE (On-Line Envelope) has been developed at CEBAF to give a graphical display of the calculated machine β function or, equivalently, the beam envelope. The time interval necessary to execute the program is somewhat less than one second, short enough that the operator can use it for setting up his lattice. Emphasis in the design was placed on speed of program execution at the expense of generality of application. As a result, the accelerator operator will be able to alter the magnetic field in any element in the machine, calculate the β functions in both planes at the entrance and exit of each magnet, and display graphs of the functions, all within one second. The time that is required is short enough that the process approximates fairly well real-time operation.

51503 (DOE/ER/40150–132) **Beam position measurement in the CEBAF recirculating linacs by use of pseudorandom pulse sequences.** Barry, W.C.; Heefner, J.W.; Jones, G.S.; Perry, J.E.; Rossmanith, R. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. Aug 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-009). Order Number DE91000627. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The recirculating linear accelerator at CEBAF presents unique problems in beam position measurement. As many as five beams with different energies may be simultaneously in the linac. Modulation of the beam intensity by pseudorandom pulse sequences offers a simple, effective method for distinguishing between the individual beamlets.

51504 (DOE/ER/40150–135) **On asymmetric collisions with large disruption parameters.** Heifets, S.A.; Krafft, G.A.; Fripp, M. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. Jun 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-003). Order Number DE91000429. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Collisions between a weak electron bunch and a strong positron bunch are studied within a flat model. Electrons are tracked through the transverse space charge field of the positron bunch, and it is shown that positrons in a storage ring may remain stable after asymmetric collisions with a weak electron bunch in spite of large values of the electron disruption parameter. The plasma oscillations that affect collisions with large disruption parameters may be suppressed by properly matching the electrons. 8 refs., 5 figs.

51505 (DOE/ER/40374–38) **Two-parameter sorting of dipoles large synchrotrons.** Li, Mingyang; Ohnuma, Shoroku. Houston Univ., TX (USA). Dept. of Physics. [1990]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40374. (CONF-900603–38: 2. European particle accelerator conference, Nice (France), 11-16 Jun 1990). Order Number DE91000681. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A relatively simple procedure for finding the optimum arrangement of a given set of dipoles in a large synchrotron has been studied when normal and skew sextupole components in dipoles are the dominant factors in its aperture reduction. The analytical figure-of-merit (F.M.) used previously in the presence of normal sextupole field has been extended to include the contribution from skew sextupole field as well. This F.M. has been used to weed out several different sorting schemes which are not very promising. For a model lattice composed of 576 dipoles in six superperiods, the dynamic aperture for 2000 turns and the linear aperture corresponding to a 5% "smear" parameter have been found from numerical trackings for several unsorted arrangements and for a "one-parameter" and a "two-parameter" sorted arrangement. In general, results indicate a significant improvement in aperture, both dynamic and linear, when two parameters are taken into account.

51506 (GSI–90-32(prepr.)) **Electron cooling of high-Z ion beams parallel to a guide magnetic field.** Goldman, S.R. (Los Alamos National Lab., NM (USA)); Hofmann, I. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jun 1990. 20p. Source: Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

We consider the cooling of high-Z ion beams through collisions with electrons whose temperature parallel to a guide magnetic field is considerably lower than their perpendicular temperature. For initial electron temperatures, magnetic fields and charged particle densities, as, for instance, are apparently attainable in the experimental storage ring (ESR) at GSI Darmstadt, electrons tend to be trapped in the vicinity of their nearest ion neighbor. This results in an energy exchange with the ions which is qualitatively different from conventional models where electron cooling is described in terms of small angle collisions or within the linearized dielectric response theory. These models are justified for situations where the potential energy of interaction is small compared to the relevant kinetic energy, e.g. for light ions. For our case of high-Z ions, on the contrary, it is the trapping process itself, which drives the cooling. Using a variety of parametrizations of the electron shielding of the ions, we find that the resulting steady state ion temperature parallel to the magnetic field is less than a factor of ten higher than the original parallel electron temperature. The e-folding times of approach to the equilibrium temperature have been found of the order of a few milliseconds for Z in the range of 20 and above. This result is encouraging with respect to the production of ultracold beams or even of a crystalline heavy ion state. (orig.).

51507 (KFTI–88-28) **Numerical simulation of transition process dynamics in a system: relativistic electron beam - back wave.** Bondarenko, V.A.; Ostrovskij, A.O.; Tkach, Yu.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 7p. (In Russian). Order Number DE91604506. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Theoretical study of nonlinear dynamics of modulated relativistic electron beam interaction with corrugated waveguide section is carried out. It is shown that pre-bunching may cause breakdown of stationary mode of regular oscillation excitation. Therewith the excited wave amplitude oscillates with time. Efficiency of the beam kinetic energy conversion to high-frequency oscillation energy is determined. 12 refs.; 3 figs.

51508 (LA-UR–90-3052) **Semi-analytical calculation of accelerating beam in a photo-injector cavity.** Takeda, Harunori. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9009123–25: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000366. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

The acceleration of electrons in an injector induces a beam emittance growth. To study the emittance growth in a photo-cathode injector, we model the acceleration process analytically. Then, the analytical model is compared with numerical simulations using the PARMELA code. Although the analytical model cannot represent the correct beam behavior caused by the space charge, we model the normalized emittance in an environment of a magnetic field produced from axial coils as represented by a mechanical angular momentum. We derive analytical relations from a relativistic equation of motion of a particle (envelope equation). Using the envelope equation, we study the emittance growth in the acceleration by a numerical integration. 2 refs., 6 figs., 1 tab.

51509 (LA-UR–90-3081) **A fluor and wire-shadow diagnostic for low-energy ion beams.** Saadatmand, K. (Grumman Corp., Bethpage, NY (USA). Corporate Research Center); Schneider, J.D.; Geisik, C.; Stevens, R.R. Jr. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009123–15: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000248. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

A video diagnostic technique utilizing a fluorescent screen and a video camera has been developed to monitor the two-dimensional beam-intensity profile and angular divergence of low-energy (25–35 keV) ion beams. Detailed off-line analysis is used to compare and augment standard beam emittance data. Experimental results on 2-D beam profiles will be presented.

51510 (LA-UR–90-3144) **Beam dynamics design of a pion linac.** Nath, S; Swain, G.; Garnett, R.; Wangler, T.P. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9009123–14: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000231. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have conducted a study of a superconducting linac to accelerate pions produced at LAMPF from 400 or 500 MeV to 925 MeV kinetic energy. For such a linac, it is necessary to keep the machine as short as practical in order to minimize the loss of beam due to particle decay, and to tailor the beam to achieve the maximum flux within the desired momentum bite at the exit. The interplay of these and other considerations with the transverse and longitudinal beam dynamics is discussed, and is illustrated with the simulated performance of reference pion-linac designs.

51511 (LA-UR–90-3175) **Coupled radio-frequency quadrupoles as compensated structures.** Browman, M.J.; Young, L.M. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009123–22: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000371. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The usefulness of radio-frequency quadrupoles (RFQs) for accelerating and bunching high-current beams in a compact-lightweight structure is well known. Until now, however, RFQs have been used only for low-energy acceleration because the structure operates in the 0 mode, and problems of mode coupling and field uniformity multiply as the length of the RFQ increases. In general, significant improvements against perturbations in the 0 or π mode can be obtained by providing the structure with another passband that couples to the first to produce a non-zero slope of the dispersion curves. Such a modified structure is called a compensated structure. The three-dimensional MAFIA codes were used to study the feasibility of designing compensated RFQs by dividing long RFQs into sections coupled together by short gaps between the end regions. We found that such a structure does have improved mode

spacing and longitudinal stability. Results from this study will be presented.

51512 (LA-UR–90-3176) **Summary of 1990 Code Conference.** Cooper, R.K.; Chan, Kwok-Chi D. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9009123–23: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000370. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The Conference on Codes and the Linear Accelerator Community was held in Los Alamos in January 1990, and had approximately 100 participants. This conference was the second in a series which has as its goal the exchange of information about codes and code practices among those writing and actually using these codes for the design and analysis of linear accelerators and their components. The first conference was held in San Diego in January 1988, and concentrated on beam dynamics codes and Maxwell solvers. This most recent conference concentrated on 3-D codes and techniques to handle the large amounts of data required for three-dimensional problems. In addition to descriptions of codes, their algorithms and implementations, there were a number of paper describing the use of many of the codes. Proceedings of both these conferences are available. 3 refs., 2 tabs.

51513 (LA-UR–90-3293) **Production of uniform and well-confined beams by nonlinear optics.** Blind, B. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-901116–5: 11. international conference on the application of accelerators in research and industry, Denton, TX (USA), 5-8 Nov 1990). Order Number DE91000210. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Particle beams with uniform and well-confined intensity distributions are desirable for medical treatments, food irradiation an ion implantation. Moreover, such beams are essential in the development of high-intensity accelerators to prevent target damage and optimize target efficiency. One accepted method for beam redistribution employs nonlinear beamline elements, in particular octupoles and to a lesser degree magnets of even higher odd multipolarity. The method is not limited to the production of uniform beam distributions. The development of this field is reviewed. Beam redistribution is explained and the degree of uniformity and confinement achievable under various conditions is discussed. A method for tuning the size of the irradiation area is presented. A possible alternative to the use of combined-function multipoles is given. The effect of beam jitter on the distribution is considered. Applications of the method are given as examples throughout.

51514 (LA-UR–90-3372) **Magnetic bunchers for the generation of high peak current, low emittance electron pulses at medium energy.** Carlsten, B.E.; McVey, B.D.; Svaton, E.M.; Magelssen, G.R.; Young, L.M. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009123–9: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000166. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper, we will outline the various physical constraints and issues for magnetic buncher design. Discussion of achromatic design and dispersion and minimizing rf power will be presented. We will provide generic designs for positive and negative dispersion, and describe the effect of curvature in the energy-phase correlation due to the sinusoidal nature of the rf fields on the output pulse shape. Methods to remove the curvature will be examined. Finally this paper will cover simple nonlinear dispersion which can compensate for the curvature.

51515 (LBL–28870) **Transverse beam dynamics studies of a heavy ion induction linac.** Garvey, T.; Eylon, S.; Fessenden, T.J.; Hahn, K.; Henestroza, E.; Keefe, D. Lawrence Berkeley Lab., CA (USA). Aug 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (HIFAN–458;CONF-9009123–18: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000244. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The multiple beam induction linac experiment (MBE-4) was built to study the accelerator physics of the low energy, electrostatically focussed end of a driver for heavy ion inertial confinement fusion. In this machine four beams of Cs^+ ions are accelerated through 24 common induction gaps while being focussed in separate AG focussing channels. Each channel consists of a syncopated FODO lattice of 30 periods. We report results of the most recent studies of the transverse beam dynamics of a single drifting (180 keV) beam in this machine. The dependence of the emittance on the zero-current phase advance shows systematic variations which may be understood in the light of previous theoretical work on this topic. This result, unique to the beam parameters of a linac for heavy ion fusion, will be discussed in the context of its implications for a driver design. In addition we will discuss recent measurements of the motion of the beam centroid through the linac. These measurements, coupled with simulations, have proven to be a powerful tool in determining the presence of misalignment errors in the lattice of the accelerator. 6 refs., 3 figs.

51516 (SLAC/AP–80) **Simulating longitudinal phase space in the SLC, from the damping rings to the final focus.** Bane, K.L.F. Stanford Univ., CA (USA). Sep 1990. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE91000761. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

At high currents the longitudinal phase space of the SLC beam is not simply described by gaussian distributions in both position and energy. The distorted ring beam, the curvature of the compressor rf, the limited energy aperture of the RTL, the wakefields in the linac, and the momentum compaction in the arc all contribute to some extent to a distortion of longitudinal phase space. In this paper we present simulation results that describe the phase space of the SLC beam, from the damping rings to the final focus area, and that include all these distorting effects. From bunch length measurements in the SLC it was discovered that the damping ring beam is lengthened and is clearly not gaussian. One author describes a potential well calculation for the ring bunch shape that agrees remarkably well with the measurements. These calculated shapes are the starting point for the simulations described in this paper. These initial distributions are propagated through the RTL, then the linac, and then the arcs. We will address questions of the bunch shape, beam tilt, beam loss, and tail population at the end of the RTL. Following this we discuss the energy spectrum at the end of the linac and the bunch shape when the beam reaches the final focus. Finally, in Appendix A we describe a method of measuring the bunch shape and the induced voltage in the SLC linac. 22 refs., 9 figs.

51517 (SLAC-PUB–5328) **Multibunch beam break-up calculations for a superconducting TeV linear collider design.** Thompson, K.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Aug 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9007171–1: 1. workshop on a TeV superconducting linear collider, Ithaca, NY (USA), 23-26 Jul 1990). Order Number DE91000057. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Multibunch beam break-up in an example of a next-generation (1 TeV center of mass energy) linear collider utilizing superconducting RF is calculated. The amount of damping of the transverse dipole cavity modes required to control this instability is estimated.

51518 (SLAC-PUB–5330) **SLED II: A new method of rf pulse compression.** Wilson, P.B.; Farkas, Z.D.; Ruth, R.D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Sep 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-9009200–12: 1990 LINAC conference, Albuquerque, NM (USA), 10-14 Sep 1990). Order Number DE91000058. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

In the SLED method of RF pulse compression, two high Q resonators store energy from an RF source for a relatively long time interval (typically 3 to 5 μsec). Triggered by a reversal in RF phase, this stored energy is then released during a much shorter interval equal to the filling time of the accelerating structure. A peak power gain on the order of three and a compression efficiency on the order of 60% are typically attained. The shape of the

output pulse is, however, a sharply decaying exponential. In SLED-II the two cavities are replaced by two lengths of resonant line, forming a Resonant Line SLED (RELS) and resulting in a flat output pulse. Therefore, RELS stages can be cascaded to give a greater peak power gain. Using two stages, a peak power gain greater than ten can be achieved with a reasonable compression efficiency. Unlike the BEC, the RELS compression factor per stage is not limited to two, albeit at the expense of intrinsic efficiency. Like the BEC, it uses long lines rather than short cavities.

51519 (SLAC-PUB–5339) **Controlling multi-bunches by a fast phase switching.** Decker, F.J.; Jobe, R.K.; Merminga, N.; Thompson, K.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Sep 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9009123–32: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000461. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

In linear accelerators with two or more bunches the beam loading of one bunch will influence the energy and energy spread the following bunches. This can be corrected by quickly changing the phase of a traveling wave-structure, so that each bunch receives a slightly different net phase. At the SLAC Linear Collider (SLC) three bunches, two (e^+,e^-) for the high energy collisions and one (e^--scavenger) for producing positrons should sit at different phases, due to their different tasks. The two e^--bunches are extracted from the damping ring at the same cycle time about 60 ns apart. Fast phase switching of the RF to the bunch length compressor in the Ring-To-Linac (RTL) section can produce the necessary advance of the scavenger bunch (about 6° in phase). This allows a low energy spread of this third bunch at the e^+-production region at 2/3 of the linac length, while the other bunches are not influenced. The principles and possible other applications of this fast phase switching as using it for multi-bunches, as well as the experimental layout for the actual RTL compressor are presented.

51520 (UCRL-JC–103785) **Reduction of beam corkscrew motion on the ETAII linear induction accelerator.** Turner, W.C.; Allen, S.L.; Brand, H.R.; Caporaso, G.J.; Chambers, F.W.; Chen, Y.-J.; Coffield, F.E.; Deadrick, F.J.; Decker, T.A.; Griffith, L.V.; Lager, D.L.; Mauer, W.J.; Nexsen, W.E.; Paul, A.C.; Renbarger, V.L.; Sampayan, S. Lawrence Livermore National Lab., CA (USA). 4 Sep 1990. 5p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009123–29: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000651. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

The ETAII linear induction accelerator (6MeV, 3kA, 70ns) is designed to drive a microwave free electron laser (FEL) and demonstrate the front end accelerator technology for a shorter wavelength FEL. Performance to date has been limited by beam corkscrew motion that is driven by energy sweep and misalignment of the solenoidal focusing magnets. Modifications to the pulse power distribution system and magnetic alignment are expected to reduce the radius of corkscrew motion from its present value of 1 cm to less than 1 mm. The modifications have so far been carried out on the first 2.7 MeV (injector plus 20 accelerator cells) and experiments are beginning. In this paper we will present calculations of central flux line alignment, beam corkscrew motion and beam brightness that are anticipated with the modified ETAII. 10 refs., 4 figs., 1 tab.

51521 (UCRL-JC–103786) **Measurement and simulation of whole beam brightness on the ETA-II [Experimental Test Accelerator-II] linear induction accelerator.** Chen, Y.J.; CLark, J.C.; Paul, A.C.; Nexsen, W.E.; Turner, W.C. Lawrence Livermore National Lab., CA (USA). 7 Aug 1990. 3p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009123–31: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000652. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Measurement of beam radius as a function of focusing strength of an upstream solenoidal field allows simultaneous determination of the beam energy, brightness and tilt of the phase space ellipse. On ETA-II beam radius has been measured by analyzing foil emitted Cherenkov light with a gated (5 ns) image intensified CCD camera. The beam energy measurement is corroborated with a spectrometer magnet and core brightness with a two hole emittance diagnostic. For a 6 MeV, 1.6 kA beam, the whole beam brightness was measured to be 4.0×10^8 A/(m-rad)^2 with an inner core (few percent) brightness of 1.2×10^9 A/(m-rad)^2. The data was simulated with a particle transport code that includes the effects of energy sweep and magnetic misalignment. The code predicts a halo produced by an orbital resonance that is also observed experimentally.

51522 (UCRL-JC–103790) **Dispersion and interbunch energy variation for an E^+E^- linear collider.** Houck, T.L. Lawrence Livermore National Lab., CA (USA). 5 Sep 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9009123–35: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000653. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recent studies concerning optimization parameters for e^+e^- super linear colliders use multiple particle bunches for each rf pulse to increase the luminosity and overall efficiency. Requirements for final focusing of the beams severely restrict the bunch to bunch energy variation during the rf pulse. To accurately determine the accelerating fields and energy variation, the dispersion related transient behavior of the rf drive pulse must be considered. A numerical study of dispersion effects on several different accelerating structures is presented.

51523 (UCRL-JC–103795) **Wake potentials and impedances for the ATA [Advanced Test Accelerator] induction cell.** Craig, G.D. Lawrence Livermore National Lab., CA (USA). 4 Sep 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009123–4: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000259. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The AMOS Wakefield Code is used to calculate the impedances of the induction cell used in the Advanced Test Accelerator (ATA) at Livermore. We present the wakefields and impedances for multipoles m = 0, 1 and 2. The ATA cell is calculated to have a maximum transverse impedance of approximately 1000 Ω/m at 875 MHz with a quality factor Q = 5. The sensitivity of the impedance spectra to modeling variations is discussed.

51524 (UCRL-JC–103796) **Theoretical/numerical investigation of induction cavity impedances for moderate to large gap widths.** DeFord, J.F. Lawrence Livermore National Lab., CA (USA). 5 Sep 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009123–26: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000648. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

In order to understand the coupling of a charged particle beam to modes in induction cells with gap width – to – beampipe radius ratio w/b > 1, the variation of the transverse Z/Q for both axially symmetric and axially asymmetric dipole modes in this regime is investigated. It is found that the gross behavior of the axially symmetric modes when w/b > 1 is at least consistent with the approximate analysis of Briggs, although a thorough comparison has not been undertaken. The axially asymmetric modes are found to be unimportant until w/b approaches 2, and they generally exhibit lower values of $Z\perp/Q$ than the axially symmetric modes.

51525 (UCRL-JC–103804) **Application of linear magnetic loss model of ferrite to induction cavity simulation.** DeFord, J.F.; Kamin, G. Lawrence Livermore National Lab., CA (USA). 5 Sep 1990. 5p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009123–28: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000650. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

A linear, frequency independent model of the rf properties of unbiased, soft ferrite has been implemented in finite-difference, time-domain, electromagnetic simulation code AMOS for the purposes of studying linac induction cavities. The simple model consists of adding a magnetic conductivity term (σ_mH) to Faraday's Law. The value of σ_m that is appropriate for a given ferrite at a particular frequency is obtained via an rf reflection experiment on a

very thin ferrite toroid in a shorted coaxial line. It was found that in the frequency range 100 to 1000 MHz, the required value of σ_m varies only slightly (<10%), and so we approximated it as a frequency independent parameter in AMOS. A description of the experimental setup and the technique used to extract the complex μ from the measurements is described. The model has been used to study the impedances of the DARHT induction cavity, and comparisons between these experimental measurements and AMOS calculations is presented. Implementation of a frequency dependent version of this model in AMOS is being pursued, and a discussion of this effort is given.

51526 Particle accelerator employing transient space charge potentials. Post, R.F. To Dept. of Energy, Washington, DC (USA). USA Patent 4,899,084/A/. 6 Feb 1990. Filed date 25 Feb 1988. USA Patent patents application 7-160,384. Int. Cl. H05H 5/00. 6p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes an accelerator for ions and charged particles. The plasma is generated and confined in a magnetic mirror field. The electrons of the plasma are heated to high temperatures. A series of local coils are placed along the axis of the magnetic mirror field. As an ion or particle beam is directed along the axis in sequence the coils are rapidly pulsed creating a space charge to accelerate and focus the beam of ions or charged particles.

4303 Auxiliaries and Components

Refer also to citation(s) 51499, 51503, 51508, 51524, 51571, 51576, 51596, 51597, 51599, 51605, 51966, 51982, 51984, 52029, 52030, 52032, 52033, 52038, 52039, 52040, 52043, 52044, 52047, 52048, 52094, 52095, 52098, 52140, 52151, 52289, 52453

51527 (BNL–43378) **Electrical insulation requirements and test procedures for SSC dipole magnets.** Sintchak, G.F.; Cottingham, J.G.; Ganetis, G.L. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900348–14: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE91000907. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The development of the basic requirements for the turn-to-turn, coil-to-coil, and coil-to-ground insulation for SSC dipoles is discussed. The insulation method is also described along with test procedures for verification of insulation integrity. Electrical tests are performed throughout the magnet assembly and fabrication process to verify that coil integrity and insulation quality of the various components and sub-assemblies are within nominal limits. These tests are also required to certify each dipole for SSC acceptance before it is installed in the cryostat and leaves the factory for final installation. The following series of tests, which are conducted at room temperature, are: resistance; inductance and "Q"; hypot; impulse; and ratiometer.

51528 (BNL–44624) **Status of the Brookhaven National Laboratory (BNL) toroidal volume H^- source.** Alessi, J.G.; Prelec, K. Brookhaven National Lab., Upton, NY (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9009200–15: 1990 LINAC conference, Albuquerque, NM (USA), 10-14 Sep 1990). Order Number DE91000121. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A volume H^- source having a toroidal discharge chamber and conical filter field has been developed. Parametric studies of this source have been in progress for two years. Extraction apertures from 0.5 cm^2 to 1.87 cm^2 have been tried, and an H^- current of up to 48 mA has been extracted. The electron-to-H^- current ratio in the extracted beam can be as low as 10 for $\approx$ 25 mA beam was 0.44πmm mrad. When operating with deuterium, the D^- output wads 50–60% of the H^- current under the same discharge conditions. The addition of cesium to the discharge increased the H^- output and decreased the electron current so that at 30 mA of H^-, one obtained an electron-to-H^- ratio of 1. Using a two gap extractor, with a dipole field in the intermediate electrode, approximately 80% of the extracted electrons could be removed from the primary beam.

51529 (CONF-900756–42) **Experimental and analytical studies on fixed mask assembly for APS with enhanced cooling.** Kuzay, T.M.; Collins, J.T.; Khounsary, A.M.; Viccaro, P.J. Argonne National Lab., IL (USA). Aug 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit; San Diego, CA (USA); 8-13 Jul 1990. Order Number DE90017818. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Advanced Photon Source (APS) to be constructed at Argonne National Laboratory (ANL) utilizes magnetic devices which generate x-ray beams with very intense heat flux levels. The Fixed Mask Assembly (FMA) is the first component to interact with the x-ray beam. Two sets of a pair of FMA channels, vertically and horizontally disposed, contain the beam rather than define it. They are subject to very large heat fluxes during containment. In current practice, the FMA channels are made of heavy, seamless copper, have rectangular cross-sections, and are cooled internally with water. Channels are set at grazing angles ranging from 1 to 6 degrees with respect to the beam, depending on the type of insertion device. APS insertion devices will impose higher heat fluxes on FMAs. Therefore, a need exists to improve the FMA engineering, keeping in mind the current design criteria and philosophy of FMAs. A comparative investigation of the conventionally achievable heat transfer coefficient "h" with water and the wall conductance of a heavy wall copper tube reveals that major resistance is on the coolant side. Therefore, there exists a significant opportunity to improve heat transfer in the tubes by enhancement of the coolant side. To this end an experimentally and analytically based research program has been adopted at the APS for investigating enhanced cooling methods and techniques. Currently, a variety of copper wool filled tubes as well as a commercially available enhanced copper tube have been subjected to laboratory tests with water and conventional heating to assess the resulting heat transfer improvement. As the research program develops, analysis shall become more detailed and more tubes shall be prepared and tested. 9 refs., 9 figs., 5 tabs.

51530 (DESY-HERA–90-09) **Studies of mechanical oscillations of superconducting quadrupole magnets and their influence on the beam stability at HERA.** Floettmann, K. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Experimentalphysik. Jul 1990. 71p. (In German). Source: Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.).

For thermal insolation purposes the superconducting coils of the magnets in the HERA proton accelerator have been suspended from the cryostat wall with glass fibre strips. Since quadrupole motion induces beam motion, it is important to examine the mechanical properties of the suspension structure. After a description of the main components of the equipment for vibration measurements, the calibration at liquid helium temperature is desribed. In the second part of the paper a simple mathematical model of the quadrupole suspension structure is developed by using Lagrange formalism. Results are compared with measured data and also experimental results for different settings of external noise sources (e.g. helium flux, vacuum pumps) are given and discussed. Finally the beam separation at the interaction point is derived by using the calculation for uncorrelated quadrupole motion from Courant and Snyder. (orig.).

51531 (DOE/ER/40150–137) **Operation of the rf controls in the CEBAF injector.** Simrock, S.N.; Fugitt, J.A.; Hovater, J.C.; Krafft, G.A.; Sinclair, C.K. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. Jun 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-004). Order Number DE91000431. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

The CEBAF injector has produced its first relativistic beam with two superconducting cavities. Six RF control modules are used to control amplitude and phase in the chopper cavities, the buncher,

the capture section, and the two superconducting cavities. In this paper the required stability and actual performance of the modules are discussed. For the superconducting cavity control, performance is consistent with energy stability of $\approx 10^{-4}$.

51532 (GSI–90-35(prepr.)) **A ^{82}Kr pilot beam for the accelerator mass spectrometry of ^{41}Ca.** Steinhof, A. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Henning, W.; Mueller, M.; Roeckl, E.; Schuell, D.; Speer, J.; Kutschera, W.; Paul, M. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 8p. (CONF-900491–: 5. international conference on accelerator mass spectrometry, Paris (France), 23-27 Apr 1990). Source: Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

The use of UNILAC accelerator for the accelerator mass spectrometry (AMS) of ^{41}Ca has the advantages of a low background and high sensitivity. The problem which prevented precise measurements in the past was the accurate determination of the transmission through the accelerator. Therefore, the possibility of a ^{82}Kr pilot beam was investigated with emphasis on the influence of a small difference in the mass-to-charge ratio on the transmission. (orig.).

51533 (INP–1414/PS, pp. 191-200) **A target for nuclear physics studies at higher energies in "COSY -Juelich".** Schult, O.W.B. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik); Koch, H.R. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

After a short description of the synchrotron storage ring COSY -Juelich under construction at the research center Juelich the effects are discussed of an internal target and its geometry on the circulating beam. A description is then given on the production of ribbon targets and on tests which have been carried out, in particular in the circulating beam of SATURNE. Finally a few problems are touched upon, which could be investigated with the use of foil targets in the circulating beam of COSY - Juelich. 33 refs., 2 figs. (author).

51534 (INP–1414/PS, pp. 301) **Design of electrostatic recoil nuclei transporter.** Balanda, A. (Uniwersytet Jagiellonski, Cracow (Poland). Inst. Fizyki); Samek, M. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

A small electrostatic recoil-nuclei transporter which can be used to study excited nuclei produced with a big competition of fission is described. (M.F.W.).

51535 (INS–824) **Development of a split coaxial RFQ for the JHP heavy ion linac.** Arai, Shigeaki. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. May 1990. 10p. Order Number DE91712925. Source: NTIS (US Sales Only), PC A02/MF A01.

A split coaxial RFQ (SCRFQ) is being developed as the front-end structure of the heavy-ion linac chain planned in the Japanese Hadron Project (JHP). The features of the INS SCRFQ is that four modulated vanes are installed and that the whole cavity comprises short module cavities. The fundamental problems concerning to the rf and mechanical characteristics were clarified and solved through studies with a cold model. This model was then converted to an accelerating model working at 50 MHz. Acceleration tests using a proton beam showed that the linac had the designed performance. A 25.5-MHz prototype for a JHP machine is now under development. The cavity, 2.1 m in length and 0.9 m in diameter, has been built, and will accelerate ions with a charge-to-mass ratio greater than 1/30 from 1 keV/u to 45 keV/u. From low-power tests so far conducted, we have found that the cavity has good rf characteristics. (author).

51536 (INS–825) **Development of an RFQ linac for unstable nuclei.** Arai, S.; Imanishi, A.; Morimoto, T.; Shibuya, S.; Tojyo, E.; Tokuda, N. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. May 1990. 8p. Order Number DE91712924. Source: NTIS (US Sales Only), PC A02/MF A01.

A split coaxial RFQ (SCRFQ) is being developed for accelerating unstable nuclei with a charge-to-mass ratio larger than 1/60 from 1 to 170 keV/u in the JHP heavy-ion linac. The SCRFQ is equipped with modulated vanes to generate ideal quadrupole and accelerating fields. The fundamental problems on the SCRFQ have been clarified and solved through studies on a cold model, and the excellent accelerating performance has been confirmed by using a proton accelerating model working at 50 MHz. A 25.5-MHz prototype for the JHP SCRFQ is now under development. The prototype, 2.1 m in length and 0.9 m in diameter, will accelerate ions with a charge-to-mass ratio larger than 1/30 from 1 to 45 keV/u. Low-power tests conducted so far show that the prototype cavity has good rf characteristics. (author).

51537 (Juel-Spez–528) **Design and construction of a measurement amplifier for use in the beam diagnosis of an accelerator ring plant.** Konrath, H. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Schicht- und Ionentechnik; Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung COSY. Nov 1989. 166p. (In German). Order Number DE91706107. Source: NTIS (US Sales Only), PC A08/MF A01.

The measurement amplifier can be used in the frequency range of 0 to 2 MHz, is VME bus compatible and has an accuracy of ± 1.5%. Its amplification of 0 to 40 dB can be set remotely. The circuit was designed with computer aid by means of the simulation program SPICE. The amplifier consists of two successive amplifier stages. The first amplifier stage uses a video operational amplifier as its main element, and the 2nd amplifier stage uses a transimpedance amplifier. A prototype was produced, in order to be able to check the simulation results and to use the experience gained in a ready to use amplifier. The sample amplifier was fitted on a VME bus PCB using screening. Optimisation was carried out on this sample and the measured properties were compared with the calculated results from simulation. The properties of the amplifier were checked from the DC characteristic, the Bode diagram, the transient behaviour, the distortion factor, the noise figure, the temperature behaviour and the channel separation. The specifications are compiled and an assessment of the amplifier is given. (orig./HP).

51538 (KEK–89-18) **Beam loading effect on rf system in proton synchrotrons.** Ninomiya, Shigeshi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Dec 1989. 38p. (In Japanese). Order Number DE91712889. Source: NTIS (US Sales Only), PC A03/MF A01.

This report describes the stability of an rf system in the presence of beam loading. The analysis is based on the transfer function method given in F. Pedersen (IEEE Trans. Nucl. Sci. NS-22, 1906 (1975)). First, the Routh-Hurwitz criterion is applied to the analysis of the stability of the rf system with a wideband cavity. Then the simplified model in which the loading effect is treated as a reduction in gain of the phase loop is developed. Secondly, the critical damping criteria of the phase loop in the rf system are derived. These criteria give a stability limit appreciably smaller than that given by the Routh-Hurwitz criterion. Finally, we discussed the technique by which the beam loading effect will be compensated. (author).

51539 (KEK–89-20) **A preliminary design of the PS-Collider: Design report 1.** Mori, Y. (and others); Yoshii, M.; Shintomi, T. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1990. 81p. (In Japanese). Order Number DE91712867. Source: NTIS (US Sales Only), PC A05/MF A01.

A preliminary design of the KEK PS-Collider(PSC), which accelerates and collides various ions from proton to gold at the energy of 5-7 GeV/u with a luminosity of 10^{25} cm^{-2}s^{-1}, is described. The PSC consists of two race-track rings intersecting at two collision points. The crossing angle at the each collision points is 5.62degrees. The basic concepts of the design are as follows; (1) As an

injector of the PSC, the present KEK 12-GeV proton synchrotron can be used efficiently with small modifications, which make it possible to time-share proton and heavy-ion acceleration. (2) The PSC consists of two rings with superconducting dipole magnets and normal conducting quadrupole magnets. The circumference of the each ring is approximately 260-m and the rings are placed in the present counter experimental hall. (3) Two collision schemes are possible. One is a head-on collision with bunched beams and the other a small crossing angle collision with coasting beams. In this design, the coasting beams collision scheme was chosen. This is mainly because of the technical difficulty of bunch-shortening and emittance blow-up due to intrabeam scattering in the bunched beam collision scheme. In this design report, details of the accelerator complex are presented and also a construction schedule is attached in the last section. (author).

51540 (KFK–4673) **Electron cooling experiments at LEAR.** Schwab, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Physik. Jun 1990. 129p. (In German). Order Number DE91706308. Source: NTIS (US Sales Only), PC A07/MF A01.

In 1987, after a longer phase of development this frist cooler to be used in routine operation in a storage ring was built into LEAR. Thereafter cooling experiments with 6, 10, 21 and 50 MeV protons, and later on (1989) also with antiprotons, were successfully performed; the number of stored ions was some 10^7 to $5x10^9$, typically. In this paper the performance of the experiments is described and the results of all cooling experiments are summarized. First of all the theory of electron cooling is described, whereby, amongst other things, the enhancement of the friction (cooling) force due to the solenoidal magnetic field is explained and whereby a possible difference in the friction force for protons and antiprotons is discussed. Thereafter a description of the LEAR cooler follows, especially of its electronic control system, together with the computer code, as it was used during the experiments. Then the beam control and diagnostic equipment is summarized, which could be used during the cooling experiments to prepare the ion beam and to determine its equilibrium properties and the friction force, respectively. Especially the analysis of the Schottky signals which showed an unusual behaviour in the case of a cold beam is explained in more detail. After describing the optimization of the cooling the presentation of the results of all cooling experiments follows. (orig./HSI).

51541 (KFTI–88-37) **Collective ion acceleration in anode plasma diode.** Stepanenko, I.A.; Tkach, Yu.V.; Pashchenko, A.V.; Komarov, A.D.; Gaponenko, N.I.; Kozachek, A.S.; Golubev, R.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 16p. (In Russian). Order Number DE91604558. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Collective carbon ion acceleration in relativistic electron beam of Start accelerator is studied. It is shown that ion acceleration is performed by a virtual cathode potential well moving self-consistently with the motion of ion flux front and break-down of acceleration is due to ion flux separation from plasma-vacuum boundary. 17 refs.; 15 figs.

51542 (LA-UR–90-3043) **The use of a spreadsheet in the design of accelerator components.** Brown, S.K.; Wadlinger, E.A. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009200–16: 1990 LINAC conference, Albuquerque, NM (USA), 10-14 Sep 1990). Order Number DE91000434. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This work was undertaken to explore the capabilities of user-friendly technology in building an easy-to-use tool that could be applied to formulate quickly a workable design for a radio-frequency quadrupole (RFQ). The tool will be extended to include additional components. This paper outlines the derivation of scaling laws from which we obtained a set of self-consistent equations that describe the behavior of an RFQ. These equations are relations between accelerator parameters (electric, field, rf frequency, zero-current transverse and longitudinal phase advances per period) and beam parameters (current, energy, and emittance) that act as guides for guides for designing RFQs. These equations show the various tradeoffs involved in choosing RFQ designs and help to choose starting points in parameter space for optimizing an RFQ for a particular requirement. By entering values in a simple spreadsheet, the design parameters of an RFQ can be calculated. The spreadsheet is fully described.

51543 (LA-UR–90-3046) **Increasing output power of an 850 MHz tetrode with a floating-deck modulator.** Rees, D.; Friedrichs, C. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9009200–17: 1990 LINAC conference, Albuquerque, NM (USA), 10-14 Sep 1990). Order Number DE91000433. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Designers of high-power amplifiers generally regard the region above 300 MHz as a domain dominated by velocity-modulated (klystron/TWT) devices. However, as the power requirements diminish, there are attractive alternatives. The high-power 850-MHz requirements of the ground test accelerator (GTA) program can be filled by 1-MW klystrons, but it would be more efficient to use a lower-power device for a 50-kW requirement. To meet the 850-MHz medium-power requirements, Los Alamos National Laboratory is developing an 850-MHz tetrode amplifier. These amplifiers will provide rf power to the momentum compactor and bunch rotator cavities of the GTA. Available tubes provide only a limited safety margin for a low-risk design at the power levels and duty factor required for GTA cavities. At 850 MHz, the output power capability of available tubes is reduced because of transit time effects and limited anode voltage holdoff. Pulsing the anode of the output tetrode amplifier will allow higher output power with minimum design risk. A floating-deck modulator acts as a high-voltage/high-current switch, so voltage is applied to the anode of the gridded tube only during the rf pulse. The anode voltage holdoff capability of the tube is substantially enhanced by operating in this mode. This paper will describe the design of the floating deck modulator and its impact on the design risk of the 850-MHz tetrode amplifier.

51544 (LA-UR–90-3094) **Application of a relational data base for documenting the Ground Test Accelerator cable routing and wiring interconnections.** Blackwell, D.B.; Rogers, W.L.; Brown, V.W.; Ekeroth, G.A.; McGill, T.O. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009123–17: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000245. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Ground Test Accelerator (GTA) has many different types of equipment and interconnections to support the operation. Various functions are performed by these equipments such as signal generation, instrument control, and diagnostics. All of the thousands of signals must be routed from the protected tunnel area into the operational control area of the building. Tabulating the routing of these cables, interconnections, terminations, and even the installation status, results in an enormous amount of data collection and maintenance. A relational data base program called Wireflex was written to allow real-time storage, instant recall, and reporting of this information. The operational environment is the VAX network with password security to protect the integrity of the stored data. The format of the program data bases, with the relatioships and interchange of information, will be described. Examples of input forms will show the type of information being stored and the indexing for searching specific entries. Reports will also be included displaying the flexibility of types as well as the ability to recover specific entries or ranges of information.

51545 (LA-UR–90-3099) **High power rf amplifiers for accelerator applications: The large orbit gyrotron and the high current, space charge enhanced relativistic klystron.** Stringfield, R.M.; Fazio, M.V.; Rickel, D.G.; Kwan, T.J.T.; Peratt, A.L.; Kinross-Wright, J.; Van Haaften, F.W.; Hoeberling, R.F.; Faehl, R.; Carlsten, B.; Destler, W.W.; Warner, L.B. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009123–13: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000241. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Los Alamos is investigating a number of high power microwave sources for their potential to power advanced accelerators. Included in this investigation are the large orbit gyrotron amplifier and oscillator (LOG) and the relativistic klystron amplifier (RKA). LOG amplifier development is newly underway. Electron beam power levels of 3 GW, 70 ns duration, are planned, with anticipated conversion efficiencies into RF on the order of 20 percent. Ongoing investigations on this device include experimental improvement of the electron beam optics, and computational studies of resonator design and RF extraction. Recent RKA studies have operated at electron beam powers into the device of 1.35 GW in microsecond duration pulses. The device has yielded modulated electron beam power approaching 300 MW using 3–5 kW of RF input drive. RF powers extracted into waveguide have been up to 70 MW, suggesting that more power is available from the device that we have converted to-date in the extractor. We have examined several aspects of operation, including beam bunching phenomena and RF power extraction techniques. In addition, investigations of the amplifier gain as a function of input drive, electron beam parameters and axial magnetic field strength also have been explored. The effect of ions formed during device operation also has been considered.

51546 (LA-UR–90-3180) **Photoelectric injector designs at Los Alamos National Laboratory.** Carlsten, B.E.; Sheffield, R.L.; McVey, B.D. Los Alamos National Lab., NM (USA). [1990]. 21p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9006242–2: Workshop on short pulse high current cathodes, Bendor (France), 18-22 Jun 1990). Order Number DE91000369. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We will describe the photoelectric injector design philosophy and capabilities at Los Alamos National Laboratory. We will discuss our simulation ability and general considerations to minimize the space-charge and rf emittance growths. In particular, we will also outline a high frequency design without magnetic bunching and a low frequency design with magnetic bunching.

51547 (LA-UR–90-3296) **Progress in photoinjectors for linacs.** Sheffield, R.L. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009123–16: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000209. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Several programs have started which are based on the photoinjector as the electron source. Some reasons for using a laser to produce an electron beam are improved beam brightness, high-charge single-bunch pulses (>50 nC), and several high-current pulses closely spaced in time. This presentation will cover present and planned activities in photoinjector development. Topics will include materials, gun designs, and present experimental results. 21 refs.

51548 (LA-UR–90-3371) **Measurement of RF surface efficiency at cryogenic temperatures using a resonant cavity.** Bolme, G.O.; Boicourt, G.P.; Booth, L.L.; Bultman, N.K.; Foley, E.; Liska, D.J.; Lohsen, R.A.; Niesen, J.B.; Rose, J.; Rusnak, B.; Spalek, G.; Wilson, N.G. Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009123–8: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000167. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Exploiting the potential efficiency gain of a normal conducting rf accelerator operated at cryogenic temperatures requires careful preparation of the rf conducting surface. Experimental apparatus has been assembled to study the surface conductivity to rf currents at 425 MHz and 850 MHz through a temperature range from room temperature to 14 K. The apparatus is built around an open-ended coaxial cavity with the cavity tubular ends below the cutoff frequency at resonance. The center conductor in the coaxial cavity is the test sample, and the use of a dielectric stand-off for the center conductor precludes the need for an rf contact joint and facilitates sample changes. The rf testing is conducted under vacuum with low-power rf. A CTI-Cryogenics cryopump coldhead is used for cryogenic temperature cycling of the test cavity. A detailed description of the apparatus and measurement procedures are presented.

51549 (LBL–28379) **The LBL 55-meter spherical grating monochromator at SSRL [Stanford Synchrotron Radiation Laboratory].** McKinney, W.R. (Lawrence Berkeley Lab., CA (USA)); Howells, M.R.; Lauritzen, T.; Chin, J.; DiGennaro, R.; Fong, E.; Gath, W.; Guigli, J.; Hogrefe, H.; Meneghetti, J.; Plate, D.; Heimann, P.A.; Terminello, L.; Ji, Z.; Shirley, D.; Senf, S. Lawrence Berkeley Lab., CA (USA). Aug 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098 ;AC03-82ER13000. (CONF-890802–32: 1989 synchrotron radiation instrumentation (SRI-6) national conference, Berkeley, CA (USA), 6-10 Aug 1989). Order Number DE91000250. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Lawrence Berkeley Laboratory 55-m spherical grating monochromator (SGM) beamline is located as a branch line of the 54-pole wiggler/undulator at the Stanford Synchrotron Radiation Laboratory (SSRL). It was designed and constructed by LBL's Center for X-Ray Optics and the engineering staff of LBL's Advanced Light Source with the cooperation and assistance of the research group of David Shirley at LBL and the staff of SSRL. The main goals of the project were to test the SGM concept and to develop a capability for designing and building a water-cooled mirror and grating capability in anticipation of the ALS. A water-cooled plane mirror deflects the beam horizontally, taking in general a small fraction of the flux from the 54-pole insertion device. This mirror is a brazed assembly of Glidcop (a proprietary alumina-dispersion-strengthened copper alloy) and OFHC copper. Its surface was finished in polished electroless nickel, then overcoated with gold as all optics in the beamline are overcoated. Next in the line is a fused silica toroid which focuses the SPEAR source vertically onto the entrance slit of the monochromator and horizontally onto the nominal position of the exit slit, in the manner of Rense and Violett. The magnification factors are 0.3x vertically and 0.7x horizontally. The monochromator is a Rowland-circle design; both slits move on large granite-based slides that maintain flatness of travel to ± 2 μm in peak-to-peak variation from straightness.

51550 (LBL–29464) **Mirrors as power filters.** Kortright, J.B. Lawrence Berkeley Lab., CA (USA). Jul 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900756–47: SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000355. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Multilayer mirrors offer advantages in power filtering compared to total reflection mirrors in both wiggler and undulator beams at third generation synchrotron radiation sources currently under construction. These advantages come at the expense of increased absorbed power in the mirror itself, and of added complexity of beamline optical design. This paper discusses these aspects.

51551 (LBL–29490) **A survey of synchrotron radiation devices producing circular or variable polarization.** Kim, Kwang-Je. Lawrence Berkeley Lab., CA (USA). Aug 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9007157–3: SPIE conference on EUV x-ray and gamma-ray instrumentation for astronomy, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000240. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We review the properties and operating principles of the new types of synchrotron radiation devices that produce circular polarization, or polarization that can be modulated in arbitrary fashion.

51552 (LIYF–1522) **On-line complex of stabilized power supply systems for the LIYaF AN USSR 1 GeV synchrocyclotron magnets and lenses.** Abrosimov, N.K.; Gerasimov, A.M.; Vasil'ev, A.M.; Dmitriev, S.P.; Korovina, L.A.; Kryshen', L.M.; Mikheev, G.F.; Novikov, V.S.; Pokrovskij, A.S.; Ryabov, G.A. AN SSSR, Leningrad (USSR). Inst. Yadernoj Fiziki. Aug 1989. 23p. (In Russian). Order Number DE91604559. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

On-line control subsystem of the LIYaF AN USSR 1 GeV synchrocyclotron designed for control and operation of stabilized power supply systems of magnets and lenses of the accelerator beam line is described. Block-diagram, operation principle and the main performances are given. Modification of the stabilized power supply systems permitted to ensure the main operation parameters

of the systems (stability, reliability, automation degree). 7 refs.; 1 fig.; 1 tab.

51553 (PB–90-257437/XAB) **Superconducting accelerating resonator for very-low-velocity ions, May 1988. Final report.** Delayen, J.R. Applied Superconductivity, Inc., Naperville, IL (USA). May 1988. 32p. Grants NSF-PHY-8420986, NSF-ISI-8602604. Source: NTIS, PC A03/MF A01.

See also PB–87-116299.

Superconducting resonators for the acceleration of very low velocity ions tend to be very sensitive to ambient vibrations, and their performance is usually limited not by their superconducting properties, but by these vibrations. Researchers have designed and built a very low velocity superconducting structure of the split-ring type which has a much reduced sensitivity to vibrations than previous similar structures. They have developed design and construction procedures which allow a reduction of both the peak surface electric field and peak surface magnetic field by 20%, as well as a new Pb plating procedure which provides improved superconducting performance while being simpler and more reproducible.

51554 (SLAC-PUB–5345) **Computer determinations of the properties of waveguide loaded cavities.** Kroll, N.M. (California Univ., San Diego, La Jolla, CA (USA)); Lin, Xin-Tian. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Sep 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9009123–33: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000463. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

Two recently developed computer methods to determine the resonant frequency and Q_{ext} of waveguide loaded cavities are described. We present an application of these methods to a cavity of simple form with a range of coupling apertures. The methods are found to be in good agreement with each other and also with experiment.

51555 (SSCL–311) **Design studies of Superconducting Super Collider (SSC) low-energy- beam-transport system using einzel lenses.** Chang, Chu Rui. Superconducting Super Collider Lab., Dallas, TX (USA). Sep 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-9009123–6: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000068. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

A 35 keV preinjector for matching a 30 mA H^-beam into the radio-frequency quadrupole (RFQ) section of the SSC linac has been designed using the SNOW code. The distinguishing feature of this injector is that the conventional gas-neutralized transport and matching units are replaced by two einzel lenses. Some advantages of this approach are discussed. 7 refs., 5 figs., 3 tabs.

51556 (SSCL–312) **HESQ [Helical Electrostatic Quadrupole], a low energy beam transport for the SSC linac.** Raparia, D. Superconducting Super Collider Lab., Dallas, TX (USA). Sep 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-9009123–10: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000069. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

A Helical Electrostatic Quadrupole (HESQ) is an option for the low energy beam transport (LEBT) of the SSC linac to transport and match a 35 keV H^- beam from a circular symmetric Magnetron ion source to a 428 MHz RFQ. Being an electrostatic focusing lens, the HESQ avoids neutralization of the H^- beam due to the background gas. The HESQ lenses provide stronger first-order focusing in contrast to weak second-order focusing of einzel lenses and is also stronger than alternating gradient focusing. In this paper, we will present a design and results of a PIC code simulation with space charge.

51557 (SSCL–313) **Beam transfer between the coupled cavity linac and the low energy booster synchrotron for the SSC [Superconducting Super Collider].** Bhandari, R.K.; Penner, S. Superconducting Super Collider Lab., Dallas, TX (USA). Sep 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-9009123–11: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000070. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Ion optical design of the transfer line, which will be used to inject H^- beam at 600 MeV from the Coupled Cavity Linac (CCL) into the Low Energy Booster (LEB) synchrotron, is described. Space charge effects of up to 50 mA average beam current have been taken into account.

51558 (UCRL–103780) **Progress in ETA-II magnetic field alignment using stretched wire and low energy electron beam techniques.** Deadrick, F.J.; Griffith, L.V. Lawrence Livermore National Lab., CA (USA). 17 Aug 1990. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-9009123–21: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000421. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Flux line alignment of the solenoidal focus magnets used on the ETA-II linear induction accelerator is a key element leading to a reduction of beam corkscrew motion. Two techniques have been used on the ETA-II accelerator to measure and establish magnet alignment. A low.energy electron beam has been used to directly map magnetic field lines, and recent work has utilized a pulsed stretched wire technique to measure magnet tilts and offsets with respect to a reference axis. This paper reports on the techniques used in the ETA-II accelerator alignment, and presents results from those measurements which show that accelerator is magnetically aligned to within $\sim\pm$200 microns. 3 refs., 8 figs.

51559 (UCRL-JC–103784) **Relativistic klystrons for high-gradient accelerators.** Westenskow, G.A. (Lawrence Livermore National Lab., CA (USA)); Aalberts, D.P.; Boyd, J.K.; Deis, G.A.; Houck, T.L.; Orzechowski, T.J.; Ryne, R.D.; Yu, S.S.; Allen, M.A.; Callin, R.S.; Deruyter, H.; Eppley, K.R.; Fant, K.S.; Fowkes, W.R.; Hoag, H.A.; KoontzLawrence Livermore National Lab., CA (USA). 5 Sep 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48 ;AC03-76SF00515 ;AC03-76SF00098. (CONF-9009123–27: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000649. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Experimental work is being performed by collaborators at LLNL, SLAC, and LBL to investigate relativistic klystrons as a possible rf power source for future high-gradient accelerators. We have learned how to overcome or previously reported problem of high power rf pulse shortening and have achieved peak rf power levels of 330 MW using an 11.4-GHz high-gain tube with multiple output structures. In these experiments the rf pulse is of the same duration as the beam current pulse. In addition, experiments have been performed on two short sections of a high-gradient accelerator using the rf power from a relativistic klystron. An average accelerating gradient of 84 MV/m has been achieved with 80-MW of rf power.

51560 (UCRL-JC–105043) **Energy sweep compensation of induction accelerators.** Sampayan, S.E.; Caporaso, G.J.; Chen, Y-J; Decker, T.A.; Turner, W.C. Lawrence Livermore National Lab., CA (USA). 12 Sep 1990. 5p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-9009123–20: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000413. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The ETA-II linear induction accelerator (LIA) is designed to drive a microwave free electron laser (FEL). Beam energy sweep must be limited to $\pm$1% for 50 ns to limit beam corkscrew motion and ensure high power FEL output over the full duration of the beam flattop. To achieve this energy sweep requirement, we have implemented a pulse distribution system and are planning implementation of a tapered pulse forming line (PFL) in the pulse generators driving acceleration gaps. The pulse distribution system assures proper phasing of the high voltage pulse to the electron beam. Additionally, cell-to-cell coupling of beam induced transients is reduced. The tapered PFL compensates for accelerator cell and loading nonlinearities. Circuit simulations show good agreement with preliminary data and predict the required energy sweep requirement can be met.

51561 (UCRL-JC–105054) **Using traveling wave structures to extract power from relativistic klystrons.** Ryne, R.D.; Yu, S.S. Lawrence Livermore National Lab., CA (USA). 19 Sep 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009123–7: Linear accelerator conference, Albuquerque, NM (USA), 9-14 Sep 1990). Order Number DE91000297. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this note is to analyze the excitation of traveling wave (TW) output structures by an RF current. Such structures are being used in relativistic klystron experiments at Lawrence Livermore National Laboratory. First we will preset a set of difference equations that describes the excitation of the cells of a TW structure. Next we will restrict our attention to structures that have identical cells, except possibly for the first and last cells. Under these circumstances one can obtain difference equations that have constant coefficients, and we will present the general solution of these equations. Lastly we will apply our results to the analysis of a TW output structure. We will show that, by appropriate choice of the quality factors (Qs) and eigenfrequencies of the first and last cells, it is possible to obtain a traveling wave solution for which there is no reflected wave and where the excitation grows linearly with cell number.

51562 Prospects for top search at the Tevatron Collider. Yoh, J. (Fermilab, Batavia, IL (US)). pp. 47-49 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the prospects for the search for top production at the Tevatron collider, at center-of-mass energy of 2 TeV. The author suggests that at least 300 produced T pairs are needed for discovery above background and that within the next several years, T masses of up to 100 GeV should be accessible. According to the author, with a TEV I upgrade in luminosity (by a factor of 50), it will be possible to reach T masses above 200 GeV.

51563 Quark gluon plasma: Overview and experimental results from E-735. Turkot, F. (Fermilab, Batavia, IL (US)). pp. 157-176 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

A review of the phenomenology associated with the effort to produce and observe quark-gluon plasma in particle collisions is presented. E-735 has taken data during the 1987 Tevatron-Collider run at square root s = 1.8 TeV in pursuit of this goal. Results in the correlation of $\langle p_t \rangle$ with multiplicity for charged particles and p_t distributions for Λ^0 and $\bar{\Lambda}^0$ are presented.

51564 Status of AGS experiment 780. Morse, W.M. (Brookhaven National Lab., Dept. of Physics, Upton, NY (US)). pp. 279-282 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the main background to $K_L^0 \rightarrow \mu e$ which is the decay $K_L^0 \rightarrow \pi e \nu_e$ where the electron neutrino has very little energy in the K rest frame and the pion decays in flight. The author has evaluated this background for a detector by Monte Carlo simulation. It should enter at about the 10^{-11} level. The main background to $K_L^0 \rightarrow e^+e^-$ is described.

51565 Plans for polarized beams at the SLC. Prescott, C.Y. (Stanford Univ., CA (USA)). pp. 299-321 of Test of electroweak theories: Polarized processes and other phenomena. Lynn, B.W.; Verzegnassi, C. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 461 (CONF-8506204–: Workshop on tests of electroweak theories, polarized processes and other phenomena, Trieste (Italy), 10-12 Jun 1985).

This paper discusses precision tests of the electroweak interactions possible at the SLC and LEP. The SLC is capable of providing longitudinal polarization of one incoming beam, the electrons, for such tests. Plans at the SLC to provide and monitor these beams are described, and physics objectives are discussed.

51566 The transition radiation detector for the DO experiment. Zylberstejn, A. pp. 492-502 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

A cylindrical three-layer transition radiation detector (TRD) has been constructed at Saclay for the DO experiment at the Fermilab Tevatron. Tests of a prototype reproducing the characteristics of the final set-up have been performed in a beam of 5 GeV/c electrons and pions. The performance of this prototype is reviewed and compared to Monte-Carlo calculations and to other experimental results. A report on the status of the final detector is given.

51567 Status of monopole and quark searches. Price, P.B. (Physics Dept., Univ. of California, Berkeley, CA (US)). pp. 792-806 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The search for monopoles and heavily ionizing electrically charged particles at the Tevatron collider has explored a higher mass region than ever before, but at relatively low integrated luminosity. Recent searches at e^+e^- colliders have reached much higher integrated luminosities, but only for lower masses. Several recent quark searches have focussed on possible production as quark- nucleus complexes at heavy ion accelerators.

4304 Storage Rings

Refer also to citation(s) 51537, 51565, 52028, 52029, 52033, 52036, 52041, 52043, 52044, 52046, 52047, 52096, 52098, 52099, 52389, 52452

51568 (BNL–45158) **Industrial participation in TRISTAN project at KEK, Japan.** Ozaki, Satoshi. Brookhaven National Lab., Upton, NY (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900348–15: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE91000897. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

Industry-Laboratory collaborations played a very important role in the construction of TRISTAN electron-positron colliding beam facility, and brought this construction project to a successful completion in a scheduled time. What had motivated the collaborations, what were the important elements in the successful collaborations and how the collaborations worked will be given based on the authors experience as the TRISTAN Project Director. It is my pleasure to participate in this meeting of IISSC, and to present a talk on my experience with industry-laboratory cooperations in the construction of a major high energy accelerator facility in Japan; namely the TRISTAN electron-positron colliding beam facility project at KEK, (National Laboratory for High Energy Physics) in Tsukuba, Japan.

51569 (CONF-901116–7) **The design of the RF cavity for the heavy ion storage ring for atomic physics.** Mosko, S.W. Oak Ridge National Lab., TN (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 11. international conference on the application of accelerators in research and industry; Denton, TX (USA); 5-8 Nov 1990. Order Number DE91000625. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An rf cavity and drive system have been designed for the proposed "Heavy Ion Storage Ring for Atomic Physics," HISTRAP, at Oak Ridge. A peak accelerating voltage of 2.5 kV per turn is required with a continuous tuning range from 200 kHz through 2.7 MHz. A single-gap, half-wave resonant configuration is used with biased ferrite tuning. The cavity structure is completely outside of the beam line/vacuum enclosure except for a single rf window that serves as an accelerating gap. Physical separation of the cavity and beam line permits in situ vacuum baking of the beam line

components at 300°C. A prototype cavity was designed, built, and tested. Development of frequency synthesizer and tuner control circuitry is under way.

51570 (DOE/ER/40150–133) **Spin matching conditions in large electron storage rings with purely horizontal beam polarization.** Rossmanith, R. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. Aug 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-011). Order Number DE91000629. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In a storage ring with a purely horizontal spin and a Siberian Snake, the spin matching conditions are similar to the spin matching conditions for vertical polarization; a combination of beam bumps has to be found which compensate the depolarizing effects. These bumps compensate the random emission of synchrotron emission on the spin. The aim of this paper is to define spin matching conditions that compensate this effect.

51571 (Juel-Spez–518) **Construction and setting to work of a dipole field measurement machine.** Decker, G. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Schicht- und Ionentechnik; Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung COSY. Aug 1989. 121p. (In German). Source: Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek.

The magnetic data of the COSY dipole (magnetisation curve, amount of the magnetic field, strength of deflection, effective length, field distribution and composition of the multipole) are determined with four coils, integrators, a core spin resonance sensor and two linear tables for positioning the coils. The coils are either turned, moved with the tables or the magnetic field is altered. All the equipment is controlled from a UNIX computer. All the measured data are automatically collected, evaluated and managed by a modular measurement program. The estimation of the accuracy of measurement (range 10^{-4}) and the test of the individual pieces of equipment show that the required accuracy of measurement of the dipole characteristics can be reached. (orig.).

51572 (Juel-Spez–529) **Criteria for the use of digital signal processors in the control technique of the COSY particle accelerator using the example of the MOTOROLA DSP56000.** Rath, U. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Schicht- und Ionentechnik; Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung COSY. Nov 1989. 94p. (In German). Order Number DE91706103. Source: NTIS (US Sales Only), PC A05/MF A01.

On the Cooler Synchrotron project (COSY), the beam measurement data and their processing are collected digitally. From the requirements for quick computing time (real time operation) and exact results, the use of digital signal processors is intended. The digital signal processor DSP 56000 from MOTOROLA was selected as the test object. The DSP 56000 has a development environment which makes it possible to test it on an IBM-PC AT. Tests are carried out which show that the simulation program corresponds to the functions and processes of the DSP 56000. The above-mentioned applications program calculates a 'fast Fourier transform' (FFT). This program is used to judge the speed of calculation and the accuracy of calculation of the signal processor. The algorithm used by the FFT program is explained. In order to judge the results of the DSP 56000, a comparison is made with the equivalent FORTRAN FFT. The results which the DSP gives on the ADM and the Fortran program are compared and assessed. The speed of calculation of the DSP 56000 is determined and is judged in comparison with the manufacturer's data for other digital signal processors. (orig./HP).

51573 (KEK–89-24) **Insertion device handbook 1990 Photon Factory.** Kitamura, Hideo (ed.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Mar 1990. 421p. (In Japanese). Order Number DE91713116. Source: NTIS (US Sales Only), PC A18/MF A01.

One of the objective of this 'Insertion Device Handbook' is to send the valuable manuscripts out to the society which were once left over, and it is intended to offer the basic data to measuring instrument staffs and PF users for developing devices and carrying out the synchrotron radiation experiment with full of originality. The contents are insertion light sources and the spectra of various light sources, the effects that insertion devices exert to electron orbits and ring operation, the design of multipole wiggler base beam line, the reconstruction plan of the PF storage ring, the reconstruction of the vacuum system accompanying the lowering of emittance, and the spectral calculation of the various light sources in the PF ring and the TRISTAN-AR. (K.I.).

51574 (KFTI–88-23) **Electronuclear experiments on internal target of the NR-2000 device.** Grigor'ev, Yu.N.; Likhachev, V.P.; Pashchuk, S.A.; Khvastunov, V.M. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 8p. (In Russian). Order Number DE91604564. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The main values characterizing possibility of nuclear-physical experiments on internal target of the NR-2000 device designed in KFTI are considered. Luminosity in the electron energy range (0.5-3 GeV) varies within 10^{33} -10^{37} $cm^{-2}xs^{-1}$. The beam energy spread is (1.7x10^{-2} -8.3x10^{-2})%. 6 refs.; 2 tabs.

51575 (SLAC-PUB–5331) **Long-term behavior of particle orbits in storage rings.** Warnock, R.L. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Aug 1990. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900601–10: 12. PANIC international conference on particles and nuclei, Cambridge, MA (USA), 24-29 Jun 1990). Order Number DE91000059. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

Short communication. STORAGE RINGS/beam dynamics; ORBITS/stability; ORBITS; STABILITY; DIFFUSION

51576 **Rare B decays: Experimental prospects and problems.** Bjorken, J.D. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 291-302 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the long-range potential contribution of hadron-hadron collisions. A survey of experimental prospects is offered.

44 INSTRUMENTATION

Refer also to citation(s) 51188, 51351, 51441, 51442, 51444, 51445, 51961

51577 (LBL–26455, pp. 50) **Bias-induced nonlinearities in neutron-transmutation-doped germanium at ^{4}He temperatures.** Kenny, T.W.; Richards, P.L.; Park, I.S.; Beeman, J.W.; Haller, E.E. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Measurements have been made of the electrical properties of neutron-transmutation-doped (NTD) Ge commonly used for thermometers at and below ^{4}He temperatures. Once the effects of changes in lattice temperature due to electrical heating are removed, the results can be separated into two categories: those related to electrical nonlinearities, and those related to internal time constants. The electrical nonlinearities were investigated by measuring the resistance of well heat-sunk thermometers as a function of applied bias voltage. The internal time constants were investigated by measuring the resistance oscillation that occurs when the thermometers are attached to a substrate undergoing a temperature oscillation. The mechanism for the internal time constant is not understood. A relationship between the internal time constant and the bias-induced nonlinearities appears likely because of their appearance together in several distinct systems dominated by hopping conductivity. Both of these experimental results have implications for the use of these thermometers as the sensing element in various detectors.

51578 (LBL–26455, pp. 51-52) **Millimeter wave quasioptical SIS [superconductor-insulator-superconductor] mixers.** Hu, Q.;

Mears, C.A.; Richards, P.L.; Lloyd, F.L. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The authors have tested the performance of planar superconductor-insulator-superconductor (SIS) mixers with log-periodic antennas at near-millimeter and submillimeter wave frequencies from 90 to 360 GHz. The large $\omega R_N C$ product (~ 10 at 90 GHz) of their $Nb/NbO_x/Pb$-In-Au junctions requires an integrated inductive tuning element to resonate the junction capacitance at the operating frequencies. The authors have used two types of integrated tuning element, both of which were designed with the aid of measurements using a Fourier transform spectrometer. Preliminary results indicate that the tuning elements can give very good mixer performance up to at least 200 GHz. An inductive wire in parallel with a five-junction array gives a minimum mixer noise temperature of 115 K (DSB) at 90 GHz with a full-width half-maximum (FWHM) bandwidth of 8 GHz. An open-ended microstrip stub in parallel with a single junction gives minimum mixer noise temperatures of 150 and 200 K (DSB) near 90 and 180 GHz with FWHM bandwidths of 4 and 3 GHz, respectively. The relatively high mixer noise temperatures compared to those of waveguide SIS mixers in a similar frequency range are attributed mainly to the losses in their optical system, which is being improved.

51579 (LBL–26455, pp. 52-53) **Numerical simulation of experimental data from planar SIS mixers with integrated tuning elements.** Mears, C.A.; Hu, Q.; Richards, P.L. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The authors have used the full Tucker quantum theory of mixing, including the quantum susceptance, to fit data from planar lithographed mm-wave mixers with bow-tie antennas and integrated RF coupling elements. Essentially perfect fits to pumped IV curves have been obtained. The deduced imbedding admittances agree well with those independently calculated from the geometry of the antenna and matching structures. The authors find that the quantum susceptance is essential to the fit and thus to predictions of the mixer performance. For junctions with moderately sharp gap structures, the quantum susceptance is especially important in the production of steps with low and/or negative dynamic conductance.

51580 (LBL–26455, pp. 53) **Superconducting components for infrared and millimeter wave receivers.** Richards, P.L.; Hu, Q. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

A review is given of the superconducting components that have been developed for infrared and millimeter wave receivers. A brief description is given of the scientific principles on which each device is based, followed by a discussion of the performance that has been achieved in terms of the appropriate figures of merit. Finally, comments are made about the possibility that useful device performance can be achieved by using the new high-T_c oxide superconductors. This review emphasizes photon-assisted quasiparticle tunneling and the SIS quasiparticle mixer, which is the only superconducting component to find substantial applications at infrared or millimeter wavelengths. Descriptions are given of the SIS quasiparticle direct detector, the Josephson-effect oscillator, the Josephson-effect parametric amplifier, and the various superconducting bolometers, for which practical applications appear possible. The less promising Josephson-effect detector and mixer and also the various ideas for superconducting photon detector are described because of the current interest in possible high-T_c versions of these devices.

51581 (LBL–26455, pp. 69) **Noise at the resistive transition: Bolometers.** Lerch, P.; Leoni, R.; Clarke, J.; Verghase, S.; Richards, P.L.; Beasley, M.R.; Geballe, T.H.; Hammond, R.H.; Rosenthal, P.A.; Spielman, S.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

In the mid-1970s, Clarke, Richards, Hoffer, and Yeh developed a very sensitive far-infrared bolometer involving a thin film of aluminum at the mid-point of the superconducting transition. The bolometer consists of a substrate, coated with an absorbing film on one side, suspended in a vacuum can by leads providing weak thermal contact to the heat bath. When radiation falls on the bolometer, the resulting increase in temperature is detected by the increase in the resistance of the aluminum film, which serves as a very sensitive thermometer. The advent of high-T_c superconductivity opens up the possibility of operating a transition-edge bolometer at temperatures above the boiling point of liquid N_2 (77 K), and this project was aimed at investigating the noise limitations in this application. Thin films of YBCO, made at Stanford, were patterned into narrow strips, with four terminals to enable one to measure the resistance and voltage noise at constant current. Each sample was mounted on a brass block suspended in a vacuum can immersed in liquid N_2. The temperature of the block could be raised above that of the bath with a resistive heater, and the resistance of the film was measured as a function of temperature. The spectral density of the voltage noise $S_V(f)$ was measured as a function of bias current I and of temperature through the resistive transition. $S_V(f)$ varied approximately as I^2/f through the transition.

51582 (LBL–26455, pp. 70-73) **Hot-electron effect in the dc SQUID.** Wellstood, F.C.; Urbina, C.; Clarke, J. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The noise energy of the dc SQUID at frequencies above the 1/f noise region scales as the temperature T, reflecting the fact that the noise originates as Nyquist noise in the resistors shunting the two Josephson junctions. The authors have studied the noise of SQUIDs cooled in a dilution refrigerator to temperatures as low as 20 mK. The authors found that the white-noise energy $S_\phi(f)/2L$ of typical devices flattened out at a value corresponding to a bath temperature of 150 mK, even though the SQUID was cooled to 20 mK; here, $S_\phi(f)$ is the spectral density of the flux noise, and L is the inductance of the SQUID loop. A detailed investigation of this saturation showed that it arose from heating of the electrons in the shunt resistors by the current biasing the SQUID. The authors have been able to reduce the heating significantly by attaching a large cooling fin to each shunt. The fins are made of the same metal as the shunts, Au (25% Cu), and are about 0.4×0.4 mm^2 in area. Hot electrons from the shunts diffuse into the fins, where they exchange energy with large numbers of cooler electrons and phonons, thereby cooling very rapidly.

4401 Radiation Instrumentation

Refer also to citation(s) 50835, 51298, 51566, 51827, 51853, 51855, 52009, 52011, 52029, 52030, 52032, 52038, 52039, 52045, 52048, 52140, 52144, 52158, 52166, 52169, 52234, 52364, 52377, 52380, 52381, 52382, 52384, 52385, 52386, 52388, 52389, 52390, 52391, 52394, 52402, 52403, 52404, 52410, 52414, 52416, 52417, 52418, 52419, 52428, 52431, 52432, 52433, 52437, 52438, 52439, 52440, 52470

51583 (BONN-IR–90-12) **Calibration of the OPAL jet chamber with UV laser beams. Measurement of the beam position with position-sensitive silicon diodes (PSD).** Koch, J. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Mar 1990. 81p. (In German). Order Number DE91706310. Source: NTIS (US Sales Only), PC A05/MF A01.

The OPAL jet chamber is calibrated with tracks produced by UV laser beams. Lateral effect diodes are used for monitoring the laser beam location in the detector. These position sensitive detectors locate the point of impact in two dimensions by the charge division method. Measurements on several diodes were carried out in order to calibrate these devices and to investigate to observed pin-cushion distortion. Using the telegraphers equation suitable expressions were obtained for describing the observed behaviour. It was shown that the magnetic field of OPAL as well as the UV laser wavelength and puls duration had no influence on the position information. (orig.).

51584 (IS-T–1458) **High precision numerical solutions to electric fields in a radial drift chamber.** Faust, J. Ames Lab., IA (USA). 21 Sep 1990. 73p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000749. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

A modification to the proportional chamber design makes it possible to achieve 5μm spatial resolution in particle tracking. Achieving this requires knowing exactly what the electric field is in the chamber, and simple approximations to the field are not accurate enough. The operation of the chamber and techniques which accurately evaluate the electric field are discussed.

51585 (KFK–4674) **A new approach for precise measurements of keV neutron capture cross sections: The examples of ^{93}Nb, ^{103}Rh, and ^{181}Ta.** Wisshak, K.; Voss, F.; Kaeppeler, F.; Reffo, G. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik. Apr 1990. 86p. Order Number DE91706307. Source: NTIS (US Sales Only), PC A05/MF A01.

A new experimental method has been implemented for precise measurements of neutron capture cross sections in the energy range from 3 to 200 keV. Neutrons are produced via the ^{7}Li(p,n)^{7}Be reaction using a pulsed 3 MV Van de Graaff accelerator. The neutron energy is determined by the time of flight technique using flight paths of less than 1 m. Capture events are detected with the Karlsruhe 4π Barium Fluoride Detector. This detector is characterized by a resolution in gamma-ray energy of 14% at 662 keV and 7% at 2.5 MeV, a time resolution of 500 ps, and a peak efficiency of 90% at 1 MeV. Capture events are registered with $\simeq$ 95% probability above a gamma-ray threshold of 2.5 MeV. The combined effect of the relatively short primary flight path, the 10 cm inner radius of the detector sphere, and of the low capture cross section of BaF_2 allows to discriminate the main background due to capture of sample scattered neutrons in the scintillator via time of flight, leaving part of the neutron energy range completely undisturbed. The high efficiency and good energy resolution for capture gamma-rays yields a further reduction of this background by using only the relevant energy channels for data evaluation. In the first measurements with the new detector, the neutron capture cross sections of ^{93}Nb, ^{103}Rh, and ^{181}Ta were determined in the energy range from 3 to 200 keV relative to gold as a standard. The cross section ratios could be determined with overall systematic uncertainties of 0.7 to 0.8%; statistical uncertainties were less than 1% in the energy range from 20 to 100 keV, if the data are combined in 20 keV wide bins. The necessary sample masses were of the order of one gram. Further improvements with respect to sensitivity and accuracy are discussed. (orig.).

51586 (LBL–27067) **An improved operating mode for a SI(LI) x-ray spectrometer.** Madden, N.W.; Goulding, F.S.; Jaklevic, J.M.; Landis, D.A.; Rossington, C.S. Lawrence Berkeley Lab., CA (USA). Apr 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900143–37: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990). Order Number DE91000358. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A new technique has been developed for restoring the charge to the feedback capacitor in charge sensitive preamplifiers. The method, termed "transient-reset," was developed for use in very low noise Si(Li) X-ray spectrometers. It has proved valuable as a diagnostic tool for evaluating the noise components of the input in these systems. The technique is described and compared with the pulsed- light and transistor-reset methods. To complement the charge restoration technique, a new configuration of Si(Li) X-ray detector with a very thin aluminum entrance window has been developed. Measurements of the effective window thickness are compared with similar results obtained on gold, nickel, and ion-implanted boron contacts. 10 refs., 8 figs., 1 tab.

51587 (LBL–27660, pp. 149-157) **New high spatial resolution x-ray detector.** Drukier, A.K. (Applied Research Corporation, Landover, MD (USA)); Chmielowski, M. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences*. 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

We describe the development of a new class of solid state particle/radiation detectors. The detector consists of a large array, say 10_5 x 10_5 of superconducting sensors and provides spatial resolution of a few microns with a reasonable number of readout channels. Subanosecond time resolution is possible. Furthermore, order-of-magnitude improvements in maximum radiative dose are expected; a dose of over one Gigarad should not destroy the detector.

51588 (MPI-PAE/Exp.El.–228) **Prospects of CsJ(Tl)-photodiode detectors for low level spectroscopy.** Kilgus, U.; Kotthaus, R.; Lange, E. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Jul 1990. 46p. Source: Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.

A detailed study of the potential of CsJ(Tl)-photodiode detectors for applications in low level spectroscopy was carried out. The energy resolution of small crystals (few cm^3) for γ-rays in the MeV range can be parametrized as ΔE (fwhm)/E=5%.E[MeV]$^{-0.69}$. In kg size detectors, where resolution is limited by electronic noise, the use of new large area low capacitance pin Si photodiodes led to significantly improved energy precision of ΔE (fwhm)=150 keV nearly independent of energy. Unfavourable light collection geometries, like in large acceptance well detectors, do not substantially degrade the energy measurement. Scintillation light yields vary slowly with temperature and time such that excellent long term stability can be expected. For the first time a systematic investigation of inherent crystal radioactivity was possible due to the improved energy resolution obtained with big crystals. Six α-active radionuclides of the Th-decay-chain were identified. The isotopes are in equilibrium with each other but not in secular equilibrium with ^{232}Th. The total α-activity varies from crystal to crystal between 2.4 and 5.5 decays/(h.cm^3) corresponding to ^{228}Th concentrations of 1.1 to 2.5x10^{-16} grams/gram. Activity from ^{238}U-chain isotopes is not seen at a level two orders of magnitude below the Th-activity. Prospects are discussed for further improved energy resolution and for applications in low level spectroscopy, specifically for a search for ^{100}Mo double beta decay. (orig.).

51589 (PNL-SA–18025) **Optimized readout system for cooled optically stimulated luminescence.** Miller, S.D.; Eschbach, P.A. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 19p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900903–1: 8. general conference of the European Physical Society, Amsterdam (Netherlands), 4-8 Sep 1990). Order Number DE91000150. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Cooled Optically Stimulated Luminescence (COSL) in CaF_2:Mn is an ionizing radiation dosimetry method recently developed at the Pacific Northwest Laboratory (PNL). In this method CaF_2:Mn crystals irradiated by gamma radiation at room temperature are cooled to liquid nitrogen temperature (77K), stimulated by ultraviolet laser light at 326 nm, and allowed to warm to room temperature. Light emission proportional to the gamma exposure occurs as the TLD warms from liquid nitrogen temperature to room temperature. The new method is an example of a highly sensitive phototransfer technique which could form the basis for future radiation dosimetry applications. Measurements to date have shown high potential for measuring gamma exposures in the range of 10 μR. The high sensitivity of the COSL technique is due in part to the larger quantum efficiency of radiative recombination at low temperatures and to the complete absence of the incandescent background associated with conventional thermoluminescent readout methods. Along with the potential for a system which is more sensitive than thermoluminescent readers, multiple COSL readouts can be performed with minimal reduction in the COSL intensity. The multiple readout capability can serve as a possible permanent dosimetry record, thus allowing the reanalysis of a questionable reading. In an attempt to optimize the sensitivity of the COSL method, a new readout system is being developed. 8 refs., 7 figs.

51590 (SAND–90-2072C) **Automated reader for solid-state fission track recorders.** Wemple, C.A. (Purdue Univ., Lafayette, IN (USA). Dept. of Nuclear Engineering); Clikeman, F.M.; Vehar, D.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p.

Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900814–6: 7. ASTM-EURATOM symposium on reactor dosimetry, Strasbourg (France), 27-31 Aug 1990). Order Number DE90015845. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

An automatic optical track identification/counting system has been developed for counting the total number of fission tracks on a fused quartz solid state track recorder. The system is capable of analyzing up to twenty recorders a day with an operator input of less than two hours. The uncertainty introduced by the counting system is about one percent. 6 refs., 2 figs.

51591 (SLAC-PUB–5232) **Review of straw chambers.** Toki, W.H. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515 ;AC02-76ER01195 ;AC03-81ER40050 ;AC (CONF-9003150–7: 5. international conference on instrumentation for colliding beam physics, Novosibirsk (USSR), 15-21 Mar 1990). Order Number DE91000053. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This is a review of straw chambers used in the HRS, MAC, Mark III, CLEO, AMY, and TPC e^+e^- experiments. The straws are 6–8 mm in diameter, operate at 1–4 atmospheres and obtain resolutions of 45–100 microns. The designs and constructions are summarized and possible improvements discussed.

51592 (SLAC-PUB–5248) **Electronic technology and the SLD detector.** Fox, J.D. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)); Dean, T.; Fox, M.J.; Freytag, D.; Gioumousis, A.; Haller, G.; Hoeflich, J.; Horelick, D.; Kang, H; Mazaheri, G.; Nelson, D.J.; Olsen, J.J.; Oxoby, G.; Paffrath, L.; Stiles, P.; Yim, A.;.Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900626–2: 2. international conference on advanced technology and particle physics, Como (Italy), 11-15 Jun 1990). Order Number DE91000054. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The SLD detector consists of five major subsystems, each with associated front-end electronics and an integrated FASTBUS control and data acquisition system. This paper highlights the choices among electronic technologies that have been developed for the SLD detector electronics. The common control, calibration, and data acquisition architectures are described. The functions of selected SLD integrated circuits, standard cells, gate arrays, and hybrids are summarized, and the integration of these functions into the common data acquisition path is described. Particular attention is directed to four areas of electronic technology developed for the SLD detector: the preamplifier hybrid designs are compared to their performance and implementation examined; the application of full custom CMOS digital circuits in SLD is compared to gate array and EPLD (electrically programmable logic device) implementations; the fiberoptic signal transmission techniques in SLD are examined and the data rates and link topology are presented; and finally, the packaging, power consumption, and cooling requirements for system functions resident inside the detector structure are explored. The rationale for the implementation choices in the SLD electronics is presented so that others might benefit from our experience.

51593 (UCRL-JC–104994) **X-ray microcalorimeters with germanium resistance thermometers.** Labov, S. (Lawrence Livermore National Lab., CA (USA)); Silver, E.; Pfafman, T.; Wai, Y.; Beeman, J.; Goulding, F.; Landis, D.; Madden, N.; Haller, E. Lawrence Livermore National Lab., CA (USA). 13 Aug 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900756–49: SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000658. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report on the current of our work on x-ray microcalorimeters for use as high resolution x-ray spectrometers. To maximize the x-ray collecting area and the signal to noise ratio, the total heat capacity of the device must be minimized. This is best achieved if the calorimeter is divided into two components, a thermal sensor and an x-ray absorber. The thermal sensor is a neutron transmutation doped (NTD) germanium resistor made as small as possible to minimize the heat capacity of the calorimeter. The thermistor can be attached to a thin x-ray absorber with large area and low heat capacity fabricated from superconducting materials such as niobium. We discuss results from our most recent studies of such superconducting absorbers and present the x-ray spectra obtained with these composite microcalorimeters at a temperature of 0.1 K. An energy resolution of 19 eV FWHM has been measured. 14 refs., 3 figs.

51594 (UCRL-JC–104995) **Test results of a prototype dielectric microcalorimeter.** Pfafman, T.E. (Lawrence Livermore National Lab., CA (USA)); Silver, E.; Labov, S.; Beeman, J.; Goulding, F.; Hansen, W.; Landis, D.; Madden, N. Lawrence Livermore National Lab., CA (USA). 13 Aug 1990. 14p. Sponsored by National Aeronautics and Space Administration. DOE Contract W-7405-ENG-48. Grant NAGW-1686. (CONF-900756–48: SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000647. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The initial development work on a dielectric microcalorimeter is presented. It focuses on the dielectric properties of the ferroelectric material $KTa_{1-x}Nb_xO_3$ (KTN). Measurements of the temperature dependent dielectric constant are given together with the first alpha particle detection results from a prototype composite microcalorimeter operating at 1.3 K. a non-thermal mechanism for detecting 6 MeV alpha particles in a monolithic KTN sample is also reported. 7 refs, 16 figs., 1 tab.

51595 (WINCO–1078) **Design of a neutron poison monitoring system of maximum sensitivity.** Piper, T.C. Westinghouse Idaho Nuclear Co., Inc., Idaho Falls, ID (USA). Jun 1990. 24p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-84ID12435. Order Number DE90018034. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The development of a neutron poison monitoring system was first reported in 1958. The present work shows that the 1985 physical configuration does not yield the maximum sensitivity achievable [i.e., sensitivity = fractional change in neutron count rate for given fractional change in concentration] and even more importantly does not achieve as low a source-to-detector leakage as possible. The maximum sensitivity design being reported herein was configured by using neutron transport calculations to determine sensitivity versus configuration. Experimental and/or calculated data for three design types are given as well as experimentally determined adverse affects caused by physically altering the new design. 6 refs., 9 figs., 3 tabs.

51596 The CDF silicon microstrip vertex detector. Haber, C. (Lawrence Berkeley Lab., Berkeley, CA (US)). pp. 443-463 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

A silicon microstrip vertex detector is being constructed as an upgrade to the CDF detector at the Fermilab Tevatron-1 $\bar{p}p$ collider. This device should allow the tagging of long-lived heavy flavors produced in $\bar{p}p$ collisions. The mechanical and electronic design of this device are described in this paper.

51597 Hadron and electron response of uranium/liquid argon calorimeter modules for the D0 detector. Wahl, H. pp. 503-527 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The authors present the results of tests made on two types of uranium/liquid argon calorimeter modules, one electromagnetic and one hadronic, constructed for the D0 detector at the Fermi-lab Tevatron Collider. The authors have exposed them to electrons and hadrons with energies between 10 and 150 GeV, and present results on energy resolution, response, electromagnetic to hadronic sensitivity ratio (e/π), and longitudinal hadronic shower development. They have also investigated the effects of adding small amounts of methane to the liquid argon in the calorimeter modules.

51598 Application of Pd silicide in the process of silicon detectors. Li, Z. (Brookhaven National Lab., Upton, NY (USA)); Chen, W.; Kraner, H.W. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 37(2): 192-197 (Apr 1990). DOE Contract AC02-76CH00016. (CONF-900143–: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990).

A new technology called a self-aligned metal-silicide process is described in the fabrication of silicon detectors. It has been found that this technology improves both detector yield and leakage current. The use of a metal silicide also gives a lower contact resistance and, depending on the thermal process, a controllable junction depth, which may be essential in the integration of detectors and their electronics.

51599 Computer automated data acquisition and control for measurement of scintillation materials and scintillating fibers. Baumbaugh, B.W. (Notre Dame Univ., IN (USA). Dept. of Physics); Bose, A.; Ditmire, T.; Kennedy, C.; Puseljic, D.; Ruchti, R.; Ryan, J.; Baumbaugh, A.; Knickerbocker, K. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 37(2): 298-304 (Apr 1990). (CONF-900143–: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990).

Scintillation materials, and scintillating fibers are being developed for potential use as tracking detectors at the SSC (Superconducting Super Collider). These fibers will need high scintillation efficiency, short decay time constants, and good transmission characteristics. This paper discusses the combined use of the Apple Macintosh family of microcomputers and custom built and commercially available hardware and software used to aid in determining suitable materials production characteristics for long scintillating fibers or capillaries. This system includes the use of a Hitachi model F-2000 fluorescence spectrophotometer, LeCroy model 3001 qVt multichannel analyzer, LeCroy 8901A CAMAC to GPIB (general purpose interface bus) interface, LeCroy 4604 scaler, and a Centent CN0170 Micro-Stepping motor controller. The software for the system is written primarily in Microsoft QuickBASIC, and is discussed in detail. The potential use of a DigiKrom 240 monochromator for understanding attenuation as a function of wavelength and for reflection coefficient measurements is discussed.

51600 Prospects for new inorganic scintillators. Derenzo, S.E. (Lawrence Berkeley Lab., CA (USA)); Moses, W.W.; Cahoon, J.L.; Perera, R.C.C.; Litton, J.E. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 37(2): 203-208 (Apr 1990). DOE Contract AC03-76SF00098. (CONF-900143–: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990).

Although scintillation has been discovered in many inorganic crystals during the past 40 years, there is continued interest in finding compounds with improved scintillation properties. However, the testing of candidate compounds has thus far been limited to those available as crystals of suitable quality and size. The authors describe a method using synchrotron x-radiation for measuring the fluorescence properties of powders, which makes accessible a much larger number of compounds. The authors present results for 85 compounds tested by this method. Scintillation from several compounds was discovered, notably CeF_3 and $PbCO_3$.

51601 An x-ray image intensifier system for precision wavelength dispersive x-ray spectroscopy. Hailey, C.J. (University of California, Lawrence Livermore National Laboratory, Livermore, CA (USA)); Lupton, J.H.; Siegmund, O.H.W.; Stewart, R.E.; Ziock, K.P. *Review of Scientific Instruments (USA),* 61(8): 2121-2126 (Aug 1990). DOE Contract W-7405-ENG-48.

We have constructed a high-resolution x-ray image intensifier (XRII) for use in atomic physics. The XRII consists of an alkali halide scintillator crystal coupled by a fiber optic to a proximity focused microchannel plate stack with a bialkali photocathode and wedge and strip readout. The useful area of the detector is 12 cm^2. We have measured full width half maximum spatial resolutions at 22 keV of 300 μm and at 122 keV of 600 μm with 0.5-mm-thick and 1.6-mm-thick CsI(Na) crystals, respectively. With NaI(Tl) crystals, x-ray arrival times can be determined with sub-100 ns resolution. In this paper we present the detailed performance of the XRII as well as a brief discussion of the theory of photoelectron limited fast timing.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

51602 (AD-A–223613/1/XAB) **Advanced single-event-upset tester. (Final report). Doctoral thesis.** Costantine, A.G. Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering. May 1990. 104p. Source: NTIS, PC A06/MF A01.

Traditionally the testing of microelectronics for single event upset (SEU) sensitivity has involved actual exposure to the cosmic ray environment by high altitude flight programs or the simulation of the cosmic ray environment through the use of heavy ion beams produced by accelerators. These simulations are expensive and of limited access, thus alternatives have been sought. This research resulted in the building of a system to measure single event upset cross section versus linear energy transfer by using Cf252 fission fragments in conjunction with thin-film scintillators. The first efforts to use Cf252 for SEU testing involved placing a Cf252 source in an evacuated chamber, bombarding the device under test, and calculating a single upset cross section that presumably was the saturation cross section. Such tests do not adequately address the uncertainties associated with the LET dispersion, and fail to usefully characterize the SEU threshold and saturation cross section of a device because there is no means to provide the SEU cross section versus LET curve. The system developed in this research effort addresses these shortcomings.

4404 Well Logging Instrumentation

Refer also to citation(s) 50596, 50597

51603 (PNL–7460) **1990 yearly calibration of Pacific Northwest Laboratory's gross-gamma borehole geophysical logging system.** Arthur, R.J. Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 45p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE91000175. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the 1990 yearly calibration of a gross-gamma geophysical pulse logging system owned by the US Department of Energy (DOE) and operated by Pacific Northwest Laboratory (PNL). The calibration was conducted to permit the continued use of this system for geological and hydrologic studies associated with remedial investigation at the Hanford Site. Primary calibrations to equivalent uranium units were conducted in borehole model standards that were recently moved to the Hanford Site from the DOE field calibration facility in Spokane, Washington. The calibrations were performed in borehole models SBL/SBH and SBA/SBB, which contain low equivalent-uranium concentrations. The integrity of the system throughout the previous year from gamma-ray monitoring was demonstrated using the before- and after-logging field calibration readings with the field source in calibration Positions 1 and 2. Most of the Position 1 readings are within an 8% limit that is set by the governing PNL technical reference procedure as a critical value above which the instrument is considered suspect. Many of the Position 2 readings exceed the 8% limit; however, the fluctuation was traced to field-source geometry variability that affected Position 1 count rates by up to 6% and Position 2 count rates by as much as 16%. Correlations were established based on two similar approaches for relating observed count rate in before- and after-logging field calibrations to equivalent uranium concentrations. The temperature drift of the gamma-ray probe was documented and amounts to less than 0.1%/°C within the temperature range 0°C to 42°C. The low-energy cutoff for the gross gamma-ray probe was determined to be between 46.5 and 59.5 keV. 10 refs., 4 figs., 13 tabs.

4405 Thermal Instrumentation

Refer also to citation(s) 51593

4406 Optical Instrumentation

Refer also to citation(s) 51266, 51328, 51459, 51478, 51632, 51686, 51760, 51791, 51926, 52382, 52399, 52401, 52402, 52437, 52534

51604 (CONF-900756–44) **Advanced infrared optically black baffle materials.** Seals, R.D. (Oak Ridge National Lab., TN (USA)); Egert, C.M.; Allred, D.D. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit; San Diego, CA (USA); 8-13 Jul 1990. Order Number DE91000561. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Infrared optically black baffle surfaces are an essential component of many advanced optical systems. All internal surfaces in advanced infrared optical sensors that require stray light management to achieve resolution are of primary concern in baffle design. Current industrial materials need improvements to meet advanced optical sensor systems requirements for optical, survivability, and endurability. Baffles are required to survive and operate in potentially severe environments. Robust diffuse-absorptive black surfaces, which are (1) thermally and mechanically stable to threats of x-ray, launch, and in-flight maneuver conditions, with specific densities to allow an acceptable weight load, (2) handleable during assembly, (3) cleanable, and (4) adaptive to affordable manufacturing, are required as optical baffle materials. In this paper an overview of recently developed advanced infrared optical baffle materials, requirements, manufacturing strategies, and the Optics MODIL (Manufacturing Operations Development and Integration Laboratory) Advanced Baffle Program will be discussed. 11 refs., 15 figs., 2 tabs.

51605 (LBL–28635) **High-resolution results from the LBL 55-meter SGM [Spherical Grating Monochromator] at SSRL [Stanford Synchrotron Radiation Laboratory] near the K-edge of carbon and nitrogen.** Heimann, P.A. (Lawrence Berkeley Lab., CA (USA)); McKinney, W.; Howells, M.; van Zee, R.D.; Medhurst, L.J.; Lauritzen, T.; Chin, J.; Meneghetti, J.; Gath, W.; Hogrefe, H.; Shirley, D.A.; Senf, F. Lawrence Berkeley Lab., CA (USA). Jul 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098 ;AC03-82ER13000. (CONF-8907130–7: 9. international conference on vacuum ultraviolet radiation physics, Honolulu, HI (USA), 17-21 Jul 1989). Order Number DE91000239. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The performance of a 55-meter Spherical Grating Monochromator (SGM) is described. A resolution of 60 MeV has been achieved at 400 eV, inferred from the linewidths of the nitrogen 1s-π^* resonance. With 0.5 eV resolution, a photon flux of 4×10^{10} photons/sec has been observed at 440 eV. An initial experiment has studied the core-shell resonances of gas-phase ethylene, C_2H_4. Vibrational fine structure was resolved both for the carbon 1s-π^* and carbon 1s-Rydberg excitations. Comparison with the vibrational frequencies of ground state ethylene implies that the ν_1 (C-H stretch) and ν_2 (C-C stretch) or ν_3 (H-C-H bend) are excited. It is suggested that the lower Rydberg orbitals, 3s and 3pσ, have molecular, anti-bonding character. 13 refs., 6 figs.

51606 (SAND–89-3112) **Photometrics at Sandia National Laboratories.** McWilliams, J.Y.; Hill, R.A.; Hughes, R.L. (eds.). Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000471. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report highlights Sandia National Laboratories' work in the following areas: photometrics and optical development; still and time-lapse photography; real-time motion photography; high-speed photography; image-motion photography; schlieren photography; ultra-high-speed photography; electronic imaging; shuttered video and high-speed video; infrared imaging radiometry; exoatmospheric photography and videography; microdensitometry and image analysis; and optical system design and development.

51607 (SAND–90-2419C) **Simplified Velocity Interferometer System for Any Reflector (VISAR) system.** Sweatt, W.C.; Stanton, P.L.; Crump, O.B. Jr. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900756–43: SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000024. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A simplified, rugged VISAR (Velocity Interferometer System for Any Reflector) system has been developed using a non-removable delay element and an essentially non-adjustable interferometer cavity. In this system, the critical interference adjustments are performed during fabrication of the cavity, freeing the user from this task. Prototype systems are easy to use and give extremely high quality results. 6 refs., 7 figs.

51608 Optical coherence multiplexing for interprocessor communications. Chu, K.W. (Sandia National Lab., Albuquerque, NM (US)); Dickey, F.M. pp. 11-23 of Optical interconnects in the computer environment. Pazaris, J.; Willenbring, G.R. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 215 (CONF-8909177–: O/E Fibers '89: meeting of the International Society for Optical Engineering, Boston, MA (USA), 5-8 Sep 1989).

This paper discusses the investigation of coherence multiplexing in which time delays exceeding the coherence time of the light source are used to achieve multiplexing. The authors have analyzed the limitations of coherence multiplexing for high-speed data links. For the geometry they are investigating, the analysis shows that the signal decreases inversely as the square of the number of channels. Noise sources include photon shot noise, excess noise (classical optical field fluctuations) and detector noise. A suitable optical source must have a smooth broad spectrum. Superluminescent diodes or edge emitting diodes are the best candidates. How all these factors affect the total information transfer rate is shown. An integrated optical circuit for coherence multiplexing being designed and built is presented.

51609 A fiber optic detection system for determination of an infrared beam spectrum in an adverse environment. Turley, W.D. (EG and G Energy Measurements, Inc., Goleta, CA (US)); Iverson, C.E.; Lutz, S.S.; Flurer, R.L.; Schaub, J.R.; Allison, S.W.; Ladish, J.S.; Caldwell, S.E. pp. 27-37 of Chemical, biochemical, and environmental fiber sensors: Volume 1172. Lieberman, R.A.; Wlodarczyk, M.T. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 318 DOE Contract AC08-88NV10617. (CONF-8909177–: O/E Fibers '89: meeting of the International Society for Optical Engineering, Boston, MA (USA), 5-8 Sep 1989).

An optical system has been developed which measured both fluence and spectral content of an infrared (IR) beam. The system integrates a luminescent sensor with a commercial spectrometer using a novel sensor and fiber-array system. Dysprosiumdoped yttrium vanadate (YVO_4:Dy) is the IR-sensitive sensor. Heating, form a pulse of IR radiation, increases the sensor efficiency of excitation in selected spectral regions. This effect is exploited to produce a sensor whose luminescence, instead of quenching with absorption of IR radiation, becomes brighter. Beam fluence at each spectral line is calculated from the measured change in the sensor luminescent output and a previously established calibration. The useful range of sensitivity is approximately 0.08 J/cm^2 to 2.0 J/cm^2.

51610 Fiber optic spectrochemical emission sensors: A detector for chlorinated and fluorinated compounds. Griffin, J.W. (Pacific Northwest Lab., Richland, WA (US)); Matson, B.S.; Olsen, K.B.; Kiefer, T.C.; Flynn, C.J. pp. 99-107 of Chemical, biochemical, and environmental fiber sensors: Volume 1172. Lieberman, R.A.; Wlodarczyk, M.T. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 318 DOE Contract AC06-76RL01830. (CONF-8909177–: O/E Fibers '89: meeting of the International Society for Optical Engineering, Boston, MA (USA), 5-8 Sep 1989).

Prior work on fiber optic spectrochemical emission sensor (FOSES) concepts has been extended to the design and fabrication of a prototype fiber optic chemical sensor system for chlorinated compounds. The sensor performs analyte dissociation and atomic excitation via a radio-frequency-excited helium plasma. The device

has been configured for field measurements of vadose-zone concentrations of carbon tetrachloride on the Hanford Reservation in southeastern Washington state. Detection and quantification of other atomic species may be achieved by varying the analytical wavelength. The sensor system design incorporates and RF excitation source: a metered, sub-atmospheric pressure helium supply system; and optical detection system; and a fiber optic umbilical to transmit analyte emissions to a central detection/data acquisition system. Sensor system design is summarized as well as performance data relating to detection limits and dynamic range.

4407 Geophysical and Meteorological Instrumentation

Refer also to citation(s) 51893

4408 Miscellaneous Instrumentation

Refer also to citation(s) 50636, 50758, 51285, 51446, 51479, 51484, 51537, 51586, 51778

51611 (BMU–1990-256) **Practical testing of capacitive strain gages for measuring of creep at 530 to 600deg C.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Hofstoetter, P. Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.); Bundesministerium fuer Umwelt-, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.). Nov 1989. 82p. (In German). Contract BMU SR 425. Source: Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

In conventional power stations, capacitive strain gages are gaining more and more significance in in-service creep rate measurements at 530deg C. The evaluation of 17 measurements under way in RWE power stations, of associated and further laboratory tests as well as supplementary laboratory tests at 520 to 575deg C provided ample details of the technique with regard to quality, stability, accuracy, laboratory tests recommended to be made and practical application. From the evaluation it followed that creep measurements can be taken even at temperatures above 550deg C as long as the stability of each single gage has been tested in the laboratory beforehand. (orig.).

51612 (CONF-900877–6) **Evolutionary developments in x-ray and electron energy loss microanalysis instrumentation for the analytical electron microscope.** Zaluzec, N.J. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 12. international congress for electron microscopy; Seattle, WA (USA); 12-18 Aug 1990. Order Number DE90017799. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Developments in instrumentation for both X-ray Dispersive and Electron Energy Loss Spectroscopy (XEDS/EELS) over the last ten years have given the experimentalist a greatly enhanced set of analytical tools for characterization. Microanalysts have waited for nearly two decades now in the hope of getting a true analytical microscope and the development of 300–400 kV instruments should have allowed us to attain this goal. Unfortunately, this has not generally been the case. While there have been some major improvements in the techniques, there has also been some devolution in the modern AEM (Analytical Electron Microscope)! In XEDS, the majority of today's instruments are still plagued by the hole count effect, which was first described in detail over a fifteen years ago. The magnitude of this problem can still reach the 20% level for medium atomic number species in a conventional off-the-shelf intermediate voltage AEM. This is an absurd situation and the manufacturers should be severely criticized. Part of the blame, however, also rests on the AEM community for not having come up with a universally agreed upon standard test procedure. Fortunately, such a test procedure is in the early stages of refinement. The proposed test specimen consists of an evaporated Cr film ~500–1000 Å thick supported upon a 3mm diameter Molybdenum 200μm aperture.

51613 (CONF-9005145–1) **The theory and practice of high resolution scanning electron microscopy.** Joy, D.C. (Tennessee Univ., Knoxville, TN (USA)). Oak Ridge National Lab., TN (USA). [1990]. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on frontiers of electron microscopy; Oak Brook, IL (USA); 21-24 May 1990. Order Number DE91000718. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recent advances in instrumentation have produced the first commercial examples of what can justifiably be called High Resolution Scanning Electron Microscopes. The key components of such instruments are a cold field emission gun, a small-gap immersion probe-forming lens, and a clean dry-pumped vacuum. The performance of these microscopes is characterized by several major features including a spatial resolution, in secondary electron mode on solid specimens, which can exceed 1nm on a routine basis; an incident probe current density of the order of 10^6 amps/cm^2; and the ability to maintain these levels of performance over an accelerating voltage range of from 1 to 30keV. This combination of high resolution, high probe current, low contamination and flexible electron-optical conditions provides many new opportunitites for the application of the SEM to materials science, physics, and the life sciences. 27 refs., 14 figs.

51614 (KCP–613-4426) **Characterization of ultrasonic transducers using pattern recognition techniques.** Ekis, J.W. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Sep 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. (CONF-901053–1: Fall conference of the American Society for Nondestructive Testing, Seattle, WA (USA), 9-12 Oct 1990). Order Number DE91000580. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes an automated method for characterizing ultrasonic transducers. A computer based test system will collect test data for a given transducer. This data set is then subjected to a pattern recognition algorithm. The results from this classification will place the transducer in a group of similar units. All the transducers in a group will have similar performance characteristics. 9 refs., 1 fig.

51615 (PTB-W–40(rev.ed.2)) **Heat meters - a survey with a list of rules and regulations for heat meters and hot water meters.** Magdeburg, H.; Stuck, D. Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.); Physikalisch-Technische Bundesanstalt - Inst. Berlin (Germany, F.R.). Nov 1989. 22p. (In German). Order Number DE91705987. Source: NTIS (US Sales Only), PC A03/MF A01.

Previous editions published as report PTB-IB–6, 1979 and 1984.

Heat meters are used for measuring the quantity of heat consumed in living spaces. Essentially only such heat meters are offered on the market which measure the water volume flown through the hot water heating as well as the temperature difference between flow and return cycle and calculate thus the quantity of heat. The characteristic quantities and measuring ranges such as temperature range, temperature difference, flow rate and nominal capacity are explained in detail. Then structure and mode of operation of such heat meters are described. In a table the measuring and application ranges of heat meters are presented, followed by criteria for their selection. Furthermore information is given about the installation of heat meters, obligatory gauging and, finally, about measuring errors of heat meters. In the appendix of the report rules and regulations for heat meters and hot water meters are listed. (HWJ).

51616 (SAND–90-1579C) **Evaluation of uniaxial and triaxial shock isolation techniques for a piezoresistive accelerometer.** Bateman, V.I.; Bell, R.G. III; Brown, F.A.; Davie, N.T.; Nusser, M.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9010172–4: 61. shock and vibration symposium, Pasadena, CA (USA), 16-18 Oct 1990). Order Number DE91000773. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Development of both uniaxial and triaxial shock isolation techniques for pyroshock and impact tests has continued this year. The uniaxial shock isolation technique has demonstrated acceptable characteristics for a temperature range of −50°F to +186°F and a

frequency bandwidth of DC to 10 kHz. The triaxial shock isolation technique has demonstrated acceptable results for a temperature range of −50°F to 70°F and a frequency bandwidth of DC to 10 kHz. 5 refs., 7 figs.

51617 (SAND–90-8224) **Design of a dual port volume measuring system.** Klevgard, P.A. Sandia National Labs., Livermore, CA (USA). Sep 1990. 84p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DR00789. Order Number DE91000883. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A volume measuring system is described which uses the ideal gas law and pressure measurements to determine an unknown vessel's volume when a gas expands into that vessel from a known volume. The design, the engineering principles, the calibration, and the accuracy of this computer-controlled system are all discussed. A set of electrical and mechanical drawings of the system is included. 3 refs., 6 figs.

51618 Considerations in the development of disposable multi-element microelectrode arrays for electrochemical sensors. Glass, R.S. (Lawrence Livermore National Lab., CA (USA). Chemistry and Materials Science Dept.); Ciarlo, D.R.; Perone, S.P. pp. 969 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 DOE Contract W-7405-ENG-48. (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

The development of sensitive and selective electrochemical sensors (as well as other types of sensors) promises to be an important scientific thrust area for many years to come. Among other reasons, improvements in the performance of electrochemical sensors should be anticipated through applications of chemically modified electrodes (and ultramicroelectrode arrays). Greater insight into methods of creating electrochemical systems with tailored chemical and electrochemical properties, porosities, etc., on the microscopic scale will allow the authors to devise sensor systems having high specificity for detection of specific compounds. They discuss how they are attempting to combine several of the above features in a hybrid, disposal electrochemical detector which they can use in natural environments.

51619 Normal incidence x-ray mirror for chemical microanalysis. Garr, M.J.; Romig, A.D. To Dept. of Energy, Washington, DC (USA). USA Patent 4,916,721/A/. 10 Apr 1990. Filed date 5 Aug 1987. USA Patent patents application 7-081,964. Int. Cl. G21K 1/06. 8p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a non-planar, focusing mirror, to be utilized in both electron column instruments and micro-x-ray fluorescence instruments for performing chemical microanalysis on a sample. It comprises a concave, generally spherical base substrate and a predetermined number of alternating layers of high atomic number material and low atomic number material contiguously formed on the base substrate. The thickness of each layer is an integral multiple of the wavelength being reflected and may vary non-uniformly according to a predetermined design. The chemical analytical instruments in which the mirror is used also include a predetermined energy source for directing energy onto the sample and a detector for receiving and detecting the x-rays emitted from the sample; the non-planar mirror is located between the sample and detector and collects the x-rays emitted from the sample at a large solid angle and focuses the collected x-rays to the sample.

51620 Aethalometer. Hansen, A.D. To Dept. of Energy, Washington, DC (USA). USA Patent 4,893,934/A/. 16 Jan 1990. Filed date 25 Jan 1988. USA Patent patents application 7-148,328. Int. Cl. G01N 21/01. 8p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes an improved aethalometer having a single light source and a single light detector and two light paths from the light source to the light detector. A quartz fiber filter is inserted in the device, the filter having a collection area in one light path and a reference area in the other light path. A gas flow path through the aethalometer housing allows ambient air to flow through the collection area of the filter so that aerosol particles can be collected on the filter. A rotating disk with an opening therethrough allows light for the light source to pass alternately through the two light paths. The voltage output of the detector is applied to a VCO and the VCO pulses for light transmission separately through the two light paths are counted and compared to determine the absorption coefficient of the collected aerosol particles.

51621 Annular array and method of manufacturing same. Day, R.A. To Dept. of Energy, Washington, DC (USA). USA Patent 4,888,861/A/. 26 Dec 1989. Filed date 10 Oct 1985. USA Patent patents application 7-786,384. Int. Cl. H01L 41/22. 6p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a method for manufacturing an annular acoustic transducer array from a plate of transducer material, which enables production of precision aligned arrays at low cost. The circular plate is sawed along at least two lines that are radial to the axis of the plate. At steps along each radial cut, the plate is rotated first in one direction and then in an opposite direction by a predetermined angle such as slightly less than 90°. The cuts result in the forming of several largely ring-shaped lands, each largely ring-shaped land being joined to the other rings of different radii by thin portions of the plate, and each ring being cut into segments. The bridges that join different rings, hold the transducer together until it can be mounted on a lens.

51622 Microwave measurement of the mass of frozen hydrogen pellets. Talanker, V.; Greenwald, M. To Dept. of Energy, Washington, DC (USA). USA Patent 4,899,100/A/. 6 Feb 1990. Filed date 1 Aug 1988. USA Patent patents application 7-226,571. Int. Cl. G01R 27/04. 8p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a nondestructive apparatus and method for measuring the mass of a moving object, based on the perturbation of the dielectric character of a resonant microwave cavity caused by the object passing through the cavity. An oscillator circuit is formed with a resonant cavity in a positive feedback loop of a microwave power amplifier. The moving object perturbs the resonant characteristics of the cavity causing a shift in the operating frequency of the oscillator proportional to the ratio of the pellet volume to the volume of the cavity. Signals from the cavity oscillation are mixed with a local oscillator. Then the IF frequency from the mixer is measured thereby providing a direct measurement of pellet mass based upon known physical properties and relationships. This apparatus and method is particularly adapted for the measurement of frozen hydrogen pellets.

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Refer also to citation(s) 50643, 50990, 51112, 51114, 51119, 52614

51623 (ANL/EAIS/TM–22) **Assessment of mission planning and rehearsal technologies for the US Special Operations Command.** Peerenboom, J.P.; Robinson, G.; Paddock, R.A. Argonne National Lab., IL (USA). Mar 1990. 38p. Sponsored by U.S. Department of Defense. DOE Contract W-31109-ENG-38. Order Number DE90014877. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Special Operations Command has identified a need for a computer-based mission planning and rehearsal system to meet the joint requirements of the air, ground, and maritime elements of the Special Operations community. This report summarizes the results of a study (1) to define the technical components and basic functionalities of such a system, (2) to assess alternative technologies and strategies for possible implementation in a prototype system, and (3) to recommend the best approach for developing a prototype system. The major areas requiring automated support are information access and exploitation, image exploitation, mission planning, and mission preview and rehearsal. Specific system requirements and performance characteristics are identified, and a technology demonstration program (in the form of a fully integrated prototype system) is recommended. Finally, a specific set of technologies and a specific development team for a technology demonstration program are proposed. 1 fig., 1 tab.

51624 (MLM-MU–90-69-0002) **Milliwatt generator heat source progress report, January–December 1989.** Saylor, R.W. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 10 Sep 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90017541. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

All hardware shipments to LANL were made on or ahead of schedule, thus satisfying all War Reserve and other hardware/yttrium requirements for the reporting period January–December 1989. A special investigation was conducted to determine the source of a surface "staining" problem observed on some T-111 components. Although the cause was not positively identified, the actions taken as a result of the investigation dramatically reduced both the frequency of occurrence and the magnitude of the problem. Hardware fabrication activates continued in an efficient and timely manner, with production losses at a minimal level. During the reporting period, a 99.4% utilization yield was realized, with a 0.8 dollar percent defectiveness. 1 ref., 15 figs., 5 tabs.

51625 (ORNL/TM–11635) **The part task trainer for airborne weapons systems: Human factors evaluation of the user interface.** Terranova, M. (Oak Ridge National Lab., TN (USA)); Hartley, D.E. Oak Ridge National Lab., TN (USA). Sep 1990. 66p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90017772. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This research examined and evaluated the human factors aspects of a part-task trainer's user interface. Questionnaires, interviews, and observational techniques were used. A number of established human factors attributes were investigated such as user control and trainer fidelity. Recommendations were given for a variety of issues such as screen design (e.g., design log-on process and procedures for user identification to be as simple as possible); text display (e.g., avoid sentences exceeding 20 words); and training for cognitive skills (e.g., train time-sharing skills for dealing with high workload environments). The results and recommendations for future enhancements were reported. An installation process was documented and comments regarding its effectiveness were included. 21 refs., 1 tab.

51626 (PNL–7459) **Evaluation and characterization of mechanisms controlling fate and effects of Army smokes: Transport, transformations, fate, and terrestrial ecological effects of brass obscurants, Final report.** Cataldo, D.A.; Ligotke, M.W.; Bolton, H. Jr.; Fellows, R.J.; Van Voris, P.; McKinley, J.P.; Mi, Shu-mei W.; McFadden, K.M. Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 172p. Sponsored by U.S. Department of Defense. DOE Contract AC06-76RL01830. Order Number DE90017710. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The primary objective of this study was to characterize the fate and response of soil and biotic components of the terrestrial environment to aerosols, deposited brass, and brass in combination with fog oil. Important physical, chemical, and biotic aspects were investigated using an environmental wind tunnel. Air/surface deposition rates were determined for foliar and soil surfaces, both in the absence and presence of fog oil. Deposition velocities for foliage ranged from 0.1 to 1.0 cm/s at wind speeds of 2 to 10 mph, respectively. Foliar contact toxicity was assessed using five different types of terrestrial vegetation representative of Army training sites and surrounding environments. No significant foliar contact toxicity was observed for brass. The weathering and chemistry of brass aerosols deposited and amended to soils was assessed, along with the impacts of acid precipitation and moisture regimes on weathering rates. Rates of brass weathering and the fate of solubilized Cu and Zn are discussed. The influence of soil weathering processes and brass solubilization on seed germination indicated no detectable effects of brass. However, moderate toxicity effects were noted after seed germination indicated no detectable effects of brass. However, moderate toxicity effects were noted after 160 days of soil incubation. The effects were proportional to soil-loading levels. Influence of soil weathering processes and contaminant solubilization on soil microbiological activities indicated that soil dehydrogenase activity was more susceptible to impacts than was phosphatase activity or microbial biomass. Nitrifying bacteria and heterotrophic bacteria were not significantly affected by brass. Invertebrates (earthworms) associated with soil contaminated with brass were only slightly impacted, and only at loading rates >445 $\mu g/cm^2$.

51627 (SAND–89-0688) **Characteristics and development report for the MC3714 thermal battery.** Scharrer, G.L.; Lasky, F.P. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000095. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the design intent, design considerations, system use, development, product characteristics, and early production history of the MC3714 Thermal Battery. This battery has a required operating life of 146 s above 24.0 V with a constant current load of 0.5 A. It is activated when the MC3830 Actuator initiates the WW42C1 Percussion Primer in the battery. The MC3714 employs the Li(Si)/LiCl-CCl/lithiated FeS_2 electrochemical system. The battery is a hermetically sealed right-circular cylinder with an antirotation ring brazed to the base of the cylinder. The battery is 50 mm long and 38.1 mm in diameter. The mass of the battery is 165 g. The battery was designed and developed to provide the power for the W82 JTA Telemetry System. 8 refs., 12 figs., 11 tabs.

51628 (SAND–90-1495) **Explosive inventory program.** Lewis, L.A.; Taylor, R.S. Sandia National Labs., Tonopah, NV (USA). Sep 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000088. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the computer program used at the Tonopah Test Range to maintain the explosive inventory. The program, which uses dBASE III or dBASE III Plus and runs on an IBM PC or compatible, has the capabilities to update (add or subtract) items, edit or delete, append, and generate various reports.

51629 (SAND–90-1575C) **Force reconstruction for impact tests of an energy-absorbing nose.** Bateman, V.I.; Garne, T.G.; McCall, D.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9010172–5: 61. shock and vibration symposium, Pasadena, CA (USA), 16-18 Oct 1990). Order Number DE91000770. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Delivery of a bomb into hard targets at speeds of up to 120 fps required the design of an energy-absorbing nose. The purpose of the nose is to decelerate the projectile and, by absorbing the kinetic energy with deformation, protect the projectile's internal components from high-level (shock) decelerations. A structural simulation of the projectile was designed to test the dynamic deformation characteristics of the energy-absorbing nose. The simulated projectile was instrumented with eight accelerometers mounted with a shock isolation technique. The dynamic force as a function of nose deformation was the desired result from the impact tests because it provides the designer with a performance criterion for the nose design. The dynamic force was obtained by combining the accelerations using the Sum of Weighted Accelerations Technique (SWAT). Results from two field tests are presented. 12 refs., 8 figs.

51630 (SAND–90-1852) **Argon gas analysis to predict water leakage into the W88.** Gillen, K.T. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000090. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Analyses of the internal argon gas concentrations monitored on surveillance units of the W84 indicates that field aging of this weapon for times up to ~4 years does not lead to important increases in the rate at which water leaks into the interior of the weapon. This implies that the EPDM environmental seals used on the W84 do not age significantly over this time period. By comparing the percentages of oxygen and argon in the internal atmosphere, an estimate of the oxygen consumption rate is made for a typical W84 unit. The argon gas analysis approach is then applied to the W88, which is sealed with a new EPDM material. Predictive expressions are derived which relate the anticipated argon gas concentrations of future, field-returned units to their water

leakage rates. The predictions are summarized in convenient plots, which can be immediately and easily applied to surveillance data as reported. Since the argon approach is sensitive enough to be useful over the entire lifetime of the W88, it can be used to point out leaking units and to determine whether long-term aging has any significant effect on the new EPDM material. 11 refs., 10 figs., 3 tabs.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 51421

51631 (SAND–90-0686) **Near-field dispersal modeling for liquid fuel-air explosives.** Gardner, D.R. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 79p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000079. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The near-field, explosive dispersal of a liquid into air has been explored using a combination of analytical and numerical models. The near-field flow regime is transient, existing only as long as the explosive forces produced by the detonation of the burster charge dominate or are approximately equal in magnitude to the aerodynamic drag forces on the liquid. The near-field model provides reasonable initial conditions for the far-field model, which is described in a separate report. The near-field model consists of the CTH hydrodynamics code and a film instability model. In particular, the CTH hydrodynamics code is used to provide initial temperature, pressure, and velocity fields, and bulk material distribution for the far-field model. The film instability model is a linear stability model for a radially expanding fluid film, and is used to provide a lower bound on the breakup time and an upper and lower bound on the initial average drop diameter for the liquid following breakup. Predictions of the liquid breakup time and the initial arithmetic average drop diameter from the model compare favorably with the sparse experimental data. 26 refs., 20 figs., 8 tabs.

51632 (UCRL–102576) **Uses of Fabry-Perot velocimeters in studies of high explosives detonation.** Breithaupt, R.D.; Tarver, C.M. Lawrence Livermore National Lab., CA (USA). 27 Aug 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900756–50: SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000813. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Fabry Perot has become an important and valuable tool by which explosive performance information can be obtained relatively easily and inexpensively. Principle uses of the Fabry Perot have been free surface, and particle velocity measurements in one dimensional studies of explosive performance. In the cylinder test, it has been very useful to resolve early wall motions. We have refined methods of characterizing new explosives i.e. equation of state, C-J pressure, via the cylinder shot, flat plate, and particle velocity techniques. All of these use Fabry Perot as one of the principle diagnostics. Each of these experimental techniques are discussed briefly and some of the results obtained. Modeling developed to fit Fabry-Perot results are described along with future testing.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 51422, 51683

51633 (AD-A–223490/4/XAB) **Magnitude: Yield relationship at various nuclear test sites - a maximum-likelihood approach using heavily censored explosive yields. Report for April 1989-April 1990.** Jih, R.S.; Shumway, R.R.; Rivers, D.W.; Wagner, R.A.; McElfresh, T.W. Teledyne Geotech, Alexandria, VA (USA). Alexandria Labs. 1 May 1990. 92p. Contract F19628-89-C-0063. (TGAL–90-03). Source: NTIS, PC A05/MF A01.

Conventional methods for estimating underground explosion yields from seismic recordings are based on the use of some appropriate magnitude:yield relationship. One of the most important parameters used to characterize the seismic signature of an underground explosion is the body-wave magnitude, mb. Thus obtaining an unbiased measurement of mb (auxiliarily Ms, pcoda, mb(Lg), Mo, and RMS Lg values) is obviously a key step in estimating the yield. During the past decade, the mb which is averaged over a well-distributed global network and which incorporates the maximum-likelihood technique into the inversion scheme has become widely accepted as a means to obtain mb estimates that avoid bias due to the detection threshold characteristics of individual network stations. Recently Soviet seismologists have published descriptions of 96 nuclear explosions conducted from 1961 through 1972 at the Semipalatinsk Test Site, in Eastern Kazakhstan. With the exception of releasing news about their peaceful nuclear explosions PNE, the Soviets have never before published such a body of information. However, out of the 72 Degelen events with announced yields, only 9 events or 12.5% were of known yields. The remaining were either left censored (66.7%) or bounded (20.8%). Similar heavy-censoring pattern can be found for other test sites. Thus the development of a procedure capable of making full use of such censored information would seem very timely and necessary.

51634 (SAND–89-3015C) **Development of future weapon storage site concepts.** Matalucci, R.V. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006184–3: 1990 Government-industry technical symposium, Williamsburg, VA (USA), 12-14 Jun 1990). Order Number DE90012585. Source: NTIS, PC A02/MF A01 - OSTI.

This paper provides information on several storage site concepts that apply a variety of advanced technologies to fixed storage sites. These technologies include (1) site entry control; (2) active and passive access delay systems; (3) detection, assessment, and surveillance of unauthorized intrusion using electronics and robotics; (4) secure communications with on-site and off-site activities; and (5) utilization of hardened storage structures, a hardened site security defense center, and a protected off-site central response force. Emphasis is placed on the integration of all the site security systems necessary for improved operational efficiency and enhanced security and survivability effectiveness primarily during peacetime and transition-to-war. Included are general descriptions of advanced storage concepts involving (1) an array of "surface-flush" vault systems, (2) an earth-bermed FORT structure, (3) an intermediate-size modified underground complex, and (4) a phased upgrade to existing igloo-storage sites.

51635 (SAND–90-0485) **Ground shock from multiple earth penetrator bursts: Effects for hexagonal weapon arrays.** Kmetyk, L.N.; Yarrington, P. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 66p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000457. Source: NTIS, PC E05/MF E01 - OSTI; GPO Dep.

This report contains 1 microfiche supplement.

Calculations have been performed with the HULL hydrocode to study ground shock effects for multiple earth penetrator weapon (EPW) bursts in hexagonal-close-packed (HCP) arrays. Several different calculational approaches were used to treat this problem. The first simulations involved two-dimensional (2D) calculations, where the hexagonal cross-section of a unit-cell in an effectively-infinite HCP array was approximated by an inscribed cylinder. Those calculations showed substantial ground shock enhancement below the center of the array. To refine the analysis, 3D unit-cell calculations were done where the actual hexagonal cross-section of the HCP array was modelled. Results of those calculations also suggested that the multiburst array would enhance ground shock effects over those for a single burst of comparable yield. Finally, 3D calculations were run in which an HCP array of seven bursts was modelled explicitly. In addition, the effects of non-simultaneity were investigated. Results of the seven-burst HCP array calculations were consistent with the unit-cell results and, in addition, provided information on the 3D lethal contour produced by such an array.

51636 **Ethics and nuclear weapons research.** Brown, P.S. (Defense Systems Program, Lawrence Livermore National Lab., Livermore, CA (US)). pp. 136-148 of Ethical issues associated with scientific and technological research for the military: Volume 577. Mitcham, C.; Siekevitz, P. The N.Y. Academy of Sciences, New York, NY (USA) (1989). pp. 277 DOE Contract W-7405-ENG-48. (CONF-8901193–: Conference on ethical issues associated with

scientific research for the military, Arlington, VA (USA), 26-28 Jan 1989).

This paper discusses the debate centered on nuclear weapons research. The author addresses the questions frequently asked of scientists involved in such research.

4504 Nuclear and Radiological Warfare

51637 (AD-A-223677/6/XAB) **Alternative futures in US nuclear strategy. Master's thesis.** Anderson, J.R. Naval Postgraduate School, Monterey, CA (USA). Dec 1989. 147p. Source: NTIS, PC A07/MF A01.

This thesis examines the future of United States nuclear strategy from the alternative futures/scenarios methodological approach. It begins by tracing the evolution of U.S. declaratory strategic policy from the end of World War II to the present. Specifically, it focuses on those particular environmental threats, constraints, and resources that were fundamental to the development of a nuclear strategy for each time period. The same kind of analysis is used to examine four alternative future security environments. Specific nuclear strategies are then developed for each alternative world scenario. The U.S. Navy's Maritime Strategy, especially the nuclear component, is presented as an example of the strategy development process. Finally, the process of strategic planning in the military and long-range planning in general are discussed.

4505 Strategic Defense Initiative

51638 (BNL-45225) **The Neutral Beam Test Facility and Radiation Effects Facility at Brookhaven National Laboratory.** McKenzie-Wilson, R.B. Brookhaven National Lab., Upton, NY (USA). [1990]. 12p. Sponsored by U.S. Department of Defense. DOE Contract AC02-76CH00016. (CONF-901116-11: 11. international conference on the application of accelerators in research and industry, Denton, TX (USA), 5-8 Nov 1990). Order Number DE91000899. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As part of the Strategic Defense Initiative (SDI) Brookhaven National Laboratory (BNL) has constructed a Neutral Beam Test Facility (NBTF) and a Radiation Effects Facility (REF). These two facilities use the surplus capacity of the 200-MeV Linac injector for the Alternating Gradient Synchrotron (AGS). The REF can be used to simulate radiation damage effects in space from both natural and man made radiation sources. The H^- beam energy, current and dimensions can be varied over a wide range leading to a broad field of application. The NBTF has been designed to carry out high precision experiments and contains an absolute reference target system for the on-line calibration of measurements carried out in the experimental hall. The H^- beam energy, current and dimensions can also be varied over a wide range but with tradeoffs depending on the required accuracy. Both facilities are fully operational and will be described together with details of the associated experimental programs.

4506 Chemical and Biological

51639 (AD-A-223374/0/XAB) **Determination of room vapor concentration from liquid chemical agent spill using GW-BASIC. Final report, August 1987-February 1990.** Kulle, T.J. Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD (USA). May 1990. 63p. (CRDEC-TR-179). Source: NTIS, PC A04/MF A01.

The IBM Personal Computer GW-BASIC Program is employed to determine the agent vapor concentration-time profile following the release of specific chemical agents (GB, GD, HD, VX) associated with an agent liquid spill in a ventilated, enclosed room. It may be used to determine the level of respiratory protection required or to predict Maximum Creditable Episodes (MCEs). A linear first-order differential equation is derived for determining the airborne agent concentrations over time resulting from the spill. Sample problems are presented using both neat agent and dilute agent liquid solutions. Comparisons are shown between the calculated agent concentrations and the agent 8-hour airborne exposure limits; from this, the level of respiratory protection can be chosen.

54 ENVIRONMENTAL SCIENCES

Refer also to citation(s) 51879, 52561

51640 (CONF-9010198-1) **Monitoring challenges and innovative ideas.** O'Neill, R.V.; Hunsaker, C.T.; Levine, D.A. Oak Ridge National Lab., TN (USA). [1990]. 33p. Sponsored by U.S. DOE Energy Research; Environmental Protection Agency. DOE Contract AC05-84OR21400. From Ecological indicators conference; Ft. Lauderdale, FL (USA); 16-19 Oct 1990. Order Number DE91000586. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Monitoring programs are difficult to design even when they focus on specific problems. Ecosystems are complex, and it is often impossible to predetermine what aspects of system structure or dynamics will respond to a specific insult. It is equally difficult to interpret whether a response is a stabilizing compensatory mechanism or a real loss of capacity to maintain the ecosystem. The problems are compounded in a broad monitoring program designed to assess ecosystem "health" at regional and continental scales. It is challenging in the extreme to monitor ecosystem response, at any scale, to past insults as well as an unknown future array of impacts. The present paper will examine some of the fundamental issues and challenges raised by large-scale monitoring efforts. The challenges will serve as a framework and as an excuse to discuss several important topics in more detail. Following the discussion of challenges, we suggest some basic innovations that could be important across a range of monitoring programs. The innovations include integrative measures, innovative methodology, and creative interpretation. 59 refs., 1 tab.

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 50274, 50330, 50367, 50520, 50762, 50763, 50764, 50765, 50767, 50768, 50769, 50770, 50773, 50937, 50955, 50983, 50989, 51007, 51049, 51078, 51294, 51414, 51425, 51610, 51626, 51639, 51706, 51713, 51746, 51747, 51748, 51751, 51754, 51755, 51756, 51759, 51801, 51854, 51870, 51872, 52604

51641 (ANL/ER-2) **Parameterizations of microphysical processes in clouds.** Lee, I.Y. Argonne National Lab., IL (USA). Environmental Research Div. Sep 1990. 118p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90017820. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

We reviewed cloud physics parameterizations comprehensively in order to examine their theoretical bases and to evaluate their applicability to mesoscale modeling. We found that the constant distribution function of hydrometeors assumed in previous work are unrealistic. To circumvent this problem, we have made new parameterizations by multiple regression on mixing ratios of water vapor, cloud water, rainwater, cloud ice, graupel, and snowflakes. We used solution fields derived from simulations with a cloud model that incorporates sophisticated treatments of microphysics and dynamics. In the detailed simulations from which they were derived, the regression parameterizations generally give better results than do the existing parameterizations tested. In a Lagrangian air parcel model under variable atmospheric conditions, the new parameterizations give consistent results and are computationally more efficient than previously available parameterizations. 77 refs., 35 figs., 4 tabs.

51642 (BNL-44947) **A least cost energy analysis of US CO_2 reduction options.** Morris, S.C. (Brookhaven National Lab., Upton, NY (USA)); Lee, J.; Goldstein, G.; Solomon, B.D.; Hill, D. Brookhaven National Lab., Upton, NY (USA). Mar 1990. 42p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900377-5: Energy and the environment in the 21st century, Cambridge, MA (USA), 26-28 Mar 1990). Order Number DE91000118. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Public policy debate on global climate change is increasingly focused on the cost of mitigating greenhouse gas emissions. Discussion in the US has centered on national energy policy and the desirability and cost of increased energy conversion efficiency and end-use conservation, and on shifting from high greenhouse gas emitting fuels to natural gas, renewable and nuclear-based energy

sources. This paper overviews the US MARKAL model, a dynamic linear programming (LP) model of US energy supply and demand. Useful energy projections are specified exogenously to the model, which then determines the optimal energy supply that can meet the demand. We have updated MARKAL with currently available energy technology cost and market penetration data and have applied it to the CO_2 reduction problem for the US. In addition, we have varied some key inputs to the model to test the sensitivity of the energy system to alternative assumptions and to overcome some of the key limitations of the input data. 27 refs., 10 figs., 5 tabs.

51643 (BNL–45190) **Global climate feedbacks: Conclusions and recommendations of the June 1990 BNL workshop.** Manowitz, B. Brookhaven National Lab., Upton, NY (USA). Aug 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9006134–1: Workshop on global climate feedbacks, Upton, NY (USA), 4-6 Jun 1990). Order Number DE91001112. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The issue of global change initiated by increases in the concentrations of CO_2 and other greenhouse gases is a scientific issue with major policy implications. The best means to examine the response of the Earth's climate to prospective perturbations in radiative forcing caused by such changes, and to other industrial activities, is modeling, specifically by means of general circulation models (GCMs) of the Earth's atmosphere and of the coupled atmosphere-ocean system. The purpose of this workshop was to identify the feedbacks inherent in the Earth's climate that actually or potentially govern the system's response to perturbations, to identify gaps in knowledge that preclude the accurate representation of these feedbacks in models, and to identify research required to represent these feedbacks accurately in models.

51644 (CONF-900572–1) **A pilot program for introduction of (ARCHIE) Automated Resource for Chemical Hazard Incident Evaluation.** Early, W.F. II (Stone and Webster Engineering Corp., Boston, MA (USA)); Livingston, M.C.; Newsom, D.E. Argonne National Lab., IL (USA). [1990]. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Hazardous material spills conference: prevention-preparedness-response; Houston, TX (USA); 13-17 May 1990. Order Number DE90017801. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Early this year, a pilot effort was presented to a combined group of Local Emergency Planning Committee and Process Industry personnel in order to introduce ARCHIE as a tool to assist in planning for and quantifying hazards resulting from the episodic release of toxic, flammable, explosive, or other acutely hazardous materials. It is the intent of this paper to present a synopsis of the training, some feedback from course attendees, and provide an appreciation for the positive interaction and improved communication that can result from such a program. 14 figs.

51645 (DMU-LUFT-A–131) **Modelling NO_2 concentrations in a street canyon.** Hertel, O.; Berkowicz, R. Danmarks Miljoeundersoegelse, Roskilde (Denmark). Oct 1989. 31p. Order Number DE91707397. Source: NTIS (US Sales Only), PC A03/MF A01.

In this report we present an evaluation of measurements of NO, NO_2 and O_3. Mainly the relation between background concentrations of ozone and NO_2 in the street will be investigated. A model for NO_2 concentrations in a street canyon will be suggested. A model for the background concentrations of NO_2 and O_3 will be described in a subsequent report, as well as the combination of the dispersion model and chemical model into a general model for NO_2 in street canyons. (author) 11 refs.

51646 (DMU-LUFT-A–136) **Evaluation of the dispersion model incorporated in the Nordic method for measuring exhaust gases from cars: Summarize report.** Hertel, O.; Berkowicz, R. Danmarks Miljoeundersoegelse, Roskilde (Denmark). Feb 1990. 27p. (In Danish). Order Number DE91707399. Source: NTIS (US Sales Only), PC A03/MF A01.

In 1984 the Nordic Council of Ministers published a Nordic calculation method for the dispersion of exhaust gases from cars. In 1987 Denmark's National Environmental Research Institute, (DMU) divison for Emission and Air Pollution, Roskilde, Denmark, cooperated with Sweden's Meteorological and Hydrological Institute in order to analyse the dispersion model to determine whether it should be modified. The work carried out in Denmark is described in addition to that carried out in the Nordic group. An Operational Street Pollution Model was developed by DMU. This model can be used in the analysis of various input parameters significance in relation to the calculation of air pollution components in streets, with emphasis on the chemical reactions that lead to the formation of NO_2. This model is described in detail. It is claimed that local meteorology (global solar radiation, temperature and wind data) street geometry and traffic data should significantly be taken into account when constructing dispersion models for exhaust gases. Chemical reactions should be included in such models and it should be remembered that ozone concentrations are important in relation to NO_2 concentration. Calculations should be made hour by hour. The advantages and disadvantages of the revised model are explained. (AB) 11 refs.

51647 (DOE/ER/60954–1, pp. 5-42) **Observations of thermally developed wind systems in mountainous terrain.** Whiteman, C.D. (Pacific Northwest Laboratory, Richland, WA (USA)). American Meteorological Society, Boston, MA (USA). Jun 1990. (CONF-8810430–: Workshop on current direction in atmospheric processes over complex terrain, Park City, UT (USA), 24-28 Oct 1988). In *Atmospheric processes over complex terrain. Volume 23, No. 45.* 323p. Order Number DE90017458. Source: NTIS, PC A15/MF A01.

Recent research has focused on the temperature structure along the slope and valley axes that leads to the wind systems. Two new tools being used in these analyses include the topographic amplification factor, which quantifies the role of the topography in producing bulk temperature gradients along a valley's axis, and atmospheric heat budgets, which identify key physical processes leading to changes in temperature structure. A simple conceptual model of diurnal wind and temperature structure evolution in deep valleys is presented. During the morning transition period, upslope flows form over heated valley sidewalls and compensatory subsidence over the valley center produced warming that eventually reverses the down-valley winds. The key role of vertical motions in transferring energy through the valley atmosphere during the morning transition period has been demonstrated by field and modeling studies. The evening transition period has received little observational attention, and the key physical processes are not yet well known. Investigation of slope wind systems has focused mostly on the nighttime flows. Recent experiments have shown that thermally driven flows within the topography may be influenced in subtle ways by the overlying circulations. This influence is nearly always present to some extent, but has not yet been systematically investigated. Recent research on strong winds that issue from a valley's exit at night and on tributary flows is briefly summarized, and some comments are made on Maloja winds and antiwind systems. The chapter ends with a summary of topics needing further research.

51648 (DOE/ER/60954–1, pp. 109-143) **Rugged terrain effects on diffusion.** Hanna, S.R. (Sigma Research Corporation, Westford, MA (USA)); Strimaitis, D.G. American Meteorological Society, Boston, MA (USA). Jun 1990. (CONF-8810430–: Workshop on current direction in atmospheric processes over complex terrain, Park City, UT (USA), 24-28 Oct 1988). In *Atmospheric processes over complex terrain. Volume 23, No. 45.* 323p. Order Number DE90017458. Source: NTIS, PC A15/MF A01.

Recent research on diffusion in rugged terrain is reviewed, with emphasis on the Environmental Protection Agency's (EPA) Complex Terrain Model Development Program and the Department of Energy's (DOE) Atmospheric Studies in Complex Terrain Program. It is shown how fluid modeling studies, field experiments, and theoretical model development programs have led to practical diffusion models, such as the EPA's Complex Terrain Diffusion Model (CTDM). This model uses the concept of a dividing-streamline height to separate the flow below this height that cannot rise over the hill from the flow above this height that does lift over the hill; however, neither CTDM nor any of the other simpler models treat any terrain beyond the first hill. This chapter also covers statistical evaluation of rugged terrain diffusion models, special studies of flow and dispersion down slopes and valleys, and methods of including diffusion in mesoscale flow models for rugged terrain. It is

seen that progress in most of these research areas is in a preliminary stage, and that field verification of fundamental concepts and models is minimal. The best diffusion models typically have an error of ±30% in simulating the maximum and mean concentrations, have a root mean square error that is the same order as the mean, and yield a correlation coefficient of about 0.50. The influences of external meterology, such as subsidence, gravity waves, multivalley circulations, sea breezes, and pooling are also not well understood. There are a few mesoscale wind field models available that can be used in conjunction with statistical particle dispersion models to estimate dispersion in complex terrain where the flow field is significantly altered by the terrain. Although these models have not been adequately tested, they are potentially very useful because they can be applied to terrain past the first hill.

51649 (KFK-PEF–70) **Combined separation and retainment of particles and gases with cleanable filters.** Loeffler, F. (Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Mechanische Verfahrenstechnik und Mechanik); Gaeng, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Jun 1990. 164p. (In German). Contract PEF 87/001/3. Order Number DE91712336. Source: NTIS (US Sales Only), PC A08/MF A01.

Filter cakes which form during dust collection process of cleanable filters may be utilized in a technique which does not only serve the particle collection, but also the binding of gases which can either react with, or be adsorbed by certain dust layer constituents. An efficient reduction of a gaseous component by the filter cake does, however, depend on numerous parameters. These include, e.g.,the chemical characteristics of the gas-solid system in question, the hydrodynamic conditions within the permeated dust layer, the filter's characteristics and the filtration conditions. Should acidic gases be required to react with alkaline particulates, then the operational temperature becomes a decisive parameter. In the case of SO_2 reduction e.g., a filtration temperature up to 900deg C must be considered. Investigations into both the dust collection at elevated temperatures and the binding of SO_2 in filter cakes from Ca-compounds were conducted, using a laboratory hot-gas filter. The influence of the higher temperature on the dust filtration was investigated with respect to fractional collection efficiency and pressure loss measurements. The effect on particle collection is positive especially in the regime of small particles. Gas reduction to be attained by the filter cake is assessed by break-through curve measurements. It is verified that under suitable conditions, a high SO_2 separation efficiency of nearly 100% can be attained with filter cakes which are less than 1 mm thick and hence, offer tolerable pressure-loss. It is also shown, that an effective gas reduction and substance exploitation depends on the texture and structure of the filter cake formed. Gas by-pass through pin-holes, cake fissures or as a result of non-uniform dust coating must be avoided. The design and dimensioning of a filter in view of a pollutant gas reduction requires the prediction of the gas penetration.

51650 (KFK-PEF–71) **Evaluation and discussion of the temporal resolution and spatial dispersion of present and future SO_2- and NO_x-emissions in the State of Baden-Wuerttemberg.** Mueller, T. (Stuttgart Univ. (Germany, F.R.). Inst. fuer Energiewirtschaft und Rationelle Energieanwendung); Boysen, B.; Friedrich, R.; Voss, A. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Jul 1990. 99p. (In German). Contract PEF 85/007/2. Order Number DE91712361. Source: NTIS (US Sales Only), PC A05/MF A01.

Based on the emission inventory elaborated for the State of Baden-Wuerttemberg for the TULLA-measuring-period, in this project a model was developed which is able to calculate hourly emissions for future time periods, for given boundary conditions and based on different scenario-assumptions in a spatial resolution of 1 kmx1 km for the whole State of Baden-Wuerttemberg. This paper describes the applied models and methodologies, presents the scenario-assumptions on which the emission calculations for the year 2000 are based, compares the emissions - as a result of the model calculations - of two weeks in january and juli 1985 to the emissions released during two weeks in january and july 2000, and discusses these results. (orig.) With 55 figs., 22 refs.

51651 (MIC–90-03966/XAB) **Accelerated sample processing, 1988-89, Phase III: Northeast cooperative woodstove study: Final report.** OMNI Environmental Services, Inc., Beaverton, OR (USA). ©1989. 13p. Contract CANMET-89170-01-SQ. Source: NTIS, PC EE07/MF E01.

The northeast cooperative woodstove study, conducted during the winter of 1988-89, measured particulate stack emissions using the AWES sampling system from 25 new-technology stoves installed in homes in the Glens Falls, N.Y. area. Five stove brands, 3 catalytic and 2 non-catalytic, were selected for the study based on their performance in a laboratory durability test. Each stove brand was represented by 5 stoves. The catalytic stoves were represented by the Blaze King Royal Heir, Country Flame BBF and the Oregon Woodstove. The non-catalytic stoves were the Country Comfort CC150 and the mid-size Regency. Each stove was sampled for 5 weekly periods spanning early January to late March. This type of sampling schedule provided an opportunity to document trends in stove emissions over the heating season as well as average performance.

51652 (MIC–90-03999/XAB) **Prediction of the environmental fate of pentachlorophenol as a function of pH using fugacity models. Report No. 89-55-K.** Mortimer, W.P. Ontario Hydro, Toronto, ON (Canada). Research Div. ©1989. 14p. Source: NTIS, PC EE07/MF E01.

The Clean Air Program of the Ontario Ministry of the Environment uses a number of criteria to classify pollutants and to determine the type of emission controls required for a given source of the pollutant. The pollutant's environmental behavior, including transport. Persistence and bioaccumulation are considered in the classification. These factors can be determined experimentally via field or laboratory studies, or through the use of the fugacity level II model if specific data are lacking. The fugacity model uses the physical, chemical and biological properties of a chemical to estimate its environmental fate. In this report, fugacity levels I and II models are applied to pentachlorophenol, the major wood pole preservative used by Canadian utility companies.

51653 (OE–90-04332) **Countdown acid rain. Summary and analysis of the seventh progress reports (July 31, 1989) by Ontario's four major sources of sulphur dioxide.** Ontario Ministry of the Environment, Toronto, ON (Canada). Jan 1990. 20p. (MICROLOG–90-04332). Source: PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Ontario's Countdown Acid Rain program was formulated in 1985 and placed an annual SO_2 emissions cap of 885 kilotonnes over the province from 1994. Caps were placed on emissions from the Inco nickel/copper smelter in Sudbury, the Falconbridge nickel/copper smelter in Sudbury, the Algoma iron ore sintering plant in Wawa, and Ontario Hydro fossil-fuel plants province-wide. Semi-annual reports are required of the companies, with the 6th report outlining the final planning phase and the 7th and later reports outlining implementation progress. This document summarizes the contents of the 7th set of reports and the responses of the government review team to each company's efforts. All companies have begun implementing abatement plans outlined in the final planning phase reports of December 1988 at a rapid pace and are generally on track in controlling emissions. However, all 4 company reports lack the necessary detail for a complete review of the implementation plan in progress, leading to a number of queries on technical and financial issues by the government review team. 2 figs., 1 tab.

51654 (OE/RT–90-03626-Vol.1, pp. 94-101, Paper A7) **Atmospheric measurements of natural hydrocarbons using gas chromatography/mass spectrometry.** Niki, H. (York Univ., Toronto, ON (Canada)); Khouw, B.H. Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto,

ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

It is now well recognized that the potential for photochemical production of ozone and other oxidants from the oxidation of natural and anthropogenic hydrocarbons, with nitrogen oxides acting as catalyst, is enormous. Due to their high reactivity coupled with their emission rates which are very sensitive to temperature, sunlight and humidity, their atmospheric distributions can exhibit a large magnitude of spatial and temporal variability. There is a lack of well-established techniques which allow measurements of a wide range of these labile organic compounds on a routine basis with adequate precision, sensitivity and selectivity. This paper describes the cryogenic flask sampling and the preconcentration method for measuring low molecular weight atmospheric hydrocarbons. An overall performance evaluation for hydrocarbon analysis by gas chromatography in combination with stainless steel flask sampling and the cryo-preconcentration method was based on both systematic examination of various operating parameters and on interlaboratory comparison of results obtained from field measurements with other groups. Furthermore, whenever possible, comparison of results from the analysis of air samples collected in stainless steel flasks with those of direct on-site measurements was done to examine sample integrity. Thus far, results reveal no inherent technical problems. Conversely, there remain a large number of sample integrity tests to be performed for heavy hydrocarbons, particularly monoterpenes and aromatics, in order to establish a fully validated handling method. 13 refs., 6 figs.

51655 (OE/RT–90-03626-Vol.1, pp. 170-177, Paper A16) **Comparison of the source locations of acidic particles and precipitation in Ontario.** Zeng, Y. (Clarkson Univ., Potsdam, NY (USA)); Hopke, P.K.; Yoon, S.J. Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The potential source contribution factor (PSCF) is a probability function based on the air parcel trajectory data couple with information regarding the nature of the contaminants measured in that air parcel. PSCF is the ratio of the probability of a contaminated air parcel having tranversed a 1° latitude by 1° longitude area to the probability that any air parcel traversed that area. Regions with high PSCF values thus have a higher probability of contributing pollutants to the measured concentrations at the receptor site. This study applies the methodology to some particulate samples collected by the Acidic Precipitation in Ontario Study (APIOS) network. The results of the analysis are compared and contrasted with those from the APIOS precipitation study. Results indicate that the U.S. midwest and east coast as source areas for most acidic species, both in precipitation and ambient particles at Dorset, Ontario. There are little differences between precipitation and ambient particles in terms of source locations, but the influence in these areas is stronger on ambient particles than on precipitation. The effect of local precipitation on the source of locations of ambient particles is not significant. 6 refs., 12 figs.

51656 (OE/RT–90-03626-Vol.1, pp. 247-250, Paper AP12) **Microwave induced catalytic destruction of some gaseous air pollutants.** Depew, M.C. (Queen's Univ., Kingston, ON (Canada)); Wan, J.K.S. Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper examines the applicability of a technique involving specific, rapid heating of certain catalytic surfaces by microwave energy as a method for destruction of acidic air pollutants. The technique involves exposing a catalyst bed through which the reagent gases are flowing to short, high intensity pulses of microwave irradiation. The catalysts chosen are selected for their strong interaction with microwaves as well as for their chemical interactions with the gaseous reagents and products. For air containing 5% SO_2, removal of >98% of the SO_2 for prolonged periods of time was possible using a variety of catalysts, especially several containing substantial Ni/NiO concentrations. In addition, aqueous slurries of Ni, Cu and Fe gave removals of >60% of the SO_2(for the Fe powder), and the production of O_2 and FeS/S_x. Removal of NO (typically 25% in He) was also examined. Several commercial copper containing catalysts used for NO_x removal were inactive. However, some Ni-containing commercial catalysts as well as in-house Ni/graphite pellets demonstrated removal of NO to levels undetectable by gas chromatography for long periods of time. The products detected included N_2, O_2, CO and CO_2 and at long experimental times N_2O. 1 fig.

51657 (ORNL/FTR–3754) **[Chemistry of the global atmosphere]: Foreign trip report, September 3–12, 1990.** Marland, G. Oak Ridge National Lab., TN (USA). 27 Sep 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000687. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the conference "The Chemistry of the Global Atmosphere," and presented a paper on the anthropogenic emission of carbon dioxide (CO_2) to the atmosphere. The conference included meetings of the International Global Atmospheric Chemistry (IGAC) programme, a core project of the International Geosphere/Biosphere Programme (IGBP) and the traveler participated in meetings on the IGAC project "Development of Global Emissions Inventories" and agreed to coordinate the working group on CO_2. Papers presented at the conference focused on the latest developments in analytical methods, modeling and understanding of atmospheric CO_2, CO, CH_4, N_2O, SO_2, NO_x, NMHCs, CFCs, and aerosols.

51658 (ORNL/FTR–3759) **[International conference on acidic deposition]: Foreign trip report, August 5, 1990–September 21, 1990.** McLaughlin, S.B. Jr. Oak Ridge National Lab., TN (USA). 5 Oct 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000873. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler took the opportunity to participate in a mini-sabbatical at the Institute of Terrestrial Ecology (ITE) in Edinburgh, Scotland, as a part of planned travel to Glasgow, Scotland, to attend the International Conference on Acidic Precipitation. The purpose of the sabbatical was to provide quality time for study and interchange of ideas with scientists at ITE working on physiological effects of acidic deposition and to allocate significant time for writing and synthesizing of results of physiological studies from the National Forest Response Program's Spruce/Fir Research Cooperative. The study focused on the very significant cytological and physiological effects of calcium deficiency in trees, a response that appears to be amplified in spruce by acidic deposition.

51659 (ORNL/M–838) **Environmental surveillance data report for the third quarter of 1989.** Goldberg, P.Y.; Horwedel, B.M.; McCollough, I.L.; Osborne-Lee, A.E.; Tardiff, M.F.; Teeters, S.W.; Valentine, C.K.; Wolf, D.A. Oak Ridge National Lab., TN (USA). Aug 1990. 98p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90017852. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

During the third quarter of 1989, over 2400 samples, which represent more than 5000 analyses and measurements, were collected by the Environmental Monitoring and Compliance Section. A network of real-time monitoring stations that telemeter 10-min averaged readings of radiation levels, total precipitation, flows, water quality parameters, and air quality parameters around Oak Ridge National Laboratory (ORNL) also reported data. In addition, three meteorological towers sent weather data for various tower heights

to a host computer every 15 min. Six isotopes, ^{3}H, ^{131}I, ^{133}I, ^{135}I, ^{191}Os, and ^{212}Pb, were the primary isotopes emitted from ORNL stacks during this quarter. The Melton Valley Complex emitted virtually all of the radioactive iodines at levels that were about the same as that for the previous quarter. The ^{212}Pb source term for ORNL decreased over the previous two quarters. The third quarter ^{191}Os emissions were the highest of the year to date. Data are not reported for noble gas or ^{125}I and ^{129}I emissions because of problems in data validation and analytical interferences. Ambient air activity for gross alpha, gross beta, and ^{131}I was consistent with the previous quarter. The Melton Branch 1 station had the highest radionuclide concentrations of all the stream locations monitored. Effluents from the processes at ORNL were sampled for radioactivity. Water samples were collected at 12 sites and analyzed for polychlorinated biphenyls (PCBs). No groundwater samples were collected during this quarter. 18 figs., 56 tabs.

51660 (PB–90-238502/XAB) **Recommended operating procedure No. 45: Analysis of nitrous oxide from combustion sources. Final report, September 1989-May 1990.** Ford, J.S. Acurex Corp., Research Triangle Park, NC (USA). Jun 1990. 33p. Contracts EPA-68-02-4701, EPA-68-02-4291. Source: NTIS, PC A03/MF A01.

The recommended operating procedure (ROP) has been prepared for use in research activities conducted by EPA's Air and Energy Engineering Research Laboratory (AEERL). The procedure applies to the measurement of nitrous oxide (N_2O) in dry gas samples extracted from gas streams where N_2O concentrations range from 0.5 to 200 ppm. N_2O concentrations are interpreted by an electron capture detector (ECD). The ECD uses a ^{63}Ni constant current cell. The upper limits of this procedure can be extended by changing the sample loop pressure to reduce the volume of sample in the look or by diluting the sample. ROPs describe non-routine or experimental research operations where some judgment in application may be warranted. ROPs may not be applicable to activities conducted by other research groups, and should not be used in place of standard operating procedures. Use of ROPs must be accompanied by an understanding of their purpose and scope.

51661 (PB–90-252628/XAB) **Estimation of seasonal and annual acidic deposition through aggregation of three-day episodic periods. Report for February 1989-1991.** Samson, P.J.; Brook, J.R.; Sillman, S. Michigan Univ., Ann Arbor, MI (USA). Dept. of Atmospheric, Oceanic and Space Science. Aug 1990. 248p. Source: NTIS, PC A11/MF A02.

A method for aggregating episodic deposition estimates has been developed and used to identify which meteorological situations merit simulation by RADM based on their likelihood of producing sulfate (SO4(-2)) wet deposition at multiple locations across eastern North America, their frequency of occurrence, and their seasonality. The aggregation technique has been performed using four years (1982 - 1985) of precipitation chemistry data from the Utility Acid Precipitation Sampling Program (UAPSP). The method developed during the project improves upon random selection. It is based on the stratification of three-day periods into categories of similar 850 mb wind flow across eastern North America. The aggregation project has provided the RADM project with a list of simulation periods which represent the range of meteorological patterns over eastern North America. The selection of storm types was based on their likelihood of producing SO4(-2) wet deposition at multiple locations across eastern North America, their frequency of occurrence, and their seasonality. The project has also provided the RADM project with scaling factors for use in weighing episodic simulation results to seasonal and annual deposition.

51662 (PB–90-253204/XAB) **Lifetimes and fates of toxic air contaminants in California's atmosphere. Final report.** Atkinson, R. California Univ., Riverside, CA (USA). Statewide Air Pollution Research Center. Mar 1990. 290p. Contract ARB-A732-107. (ARB-R–90/441). Source: NTIS, PC A13/MF A02.

A literature review of the atmospheric chemistry of eight potentially toxic air contaminants was carried out: chloroform, 1,3-butadiene, benzo(a)pyrene (BaP; a polycyclic aromatic hydrocarbon or PAH), formaldehyde, acetaldehyde, ethylene oxide, styrene, and diesel exhaust particles (including gas- and particle-phase PAHs and derivatives). Experimental studies were carried out on styrene (reaction with nitrate radical and ozone), 1,4-dioxane (reaction with ozone), nitrobenzene (reaction with ozone), and p-dichlorobenzene (reaction with nitrate radical and ozone). These data were obtained by the California Air Resources Board for incorporation into reports on exposure assessments for these compounds, which is required as part of the process of identifying and controlling toxic air contaminants. Also investigated were ring-retaining products formed from the hydroxyl radical reactions (in the presence of nitrogen oxides) with benzene, toluene, and the three xylene isomers. The resulting data showed that new chemical mechanisms for the atmospheric chemistry of the aromatic hydrocarbons are needed.

51663 (PB–90-255399/XAB) **User's manual for OZIPM-4. Volume 2. Computer code. Final report.** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Jul 1989. 173p. (EPA–450/4-89/009B). Source: NTIS, PC A08/MF A01.

The document lists the OZIPM-4 program and describes modifications necessary to run the program on several different computers.

51664 (PB–90-255407/XAB) **PC-based system for generating EKMA input files. Final report.** Systems Applications, Inc., San Rafael, CA (USA). Nov 1988. 96p. Contract EPA-68-02-4352. Source: NTIS, PC A05/MF A01.

OZIPM-4 is a model which allows the user to estimate the volatile organic compound (VOC) control requirement for a city in order to achieve the national ambient air quality standard for ozone. The document describes a PC-based system which assists the user in creating input files. The software is only available for an IBM-PC or compatible machine. Files built using the system can be uploaded to a mainframe computer.

51665 (PB–90-255415/XAB) **Consideration of transported ozone and precursors and their use in EKMA. Final report.** Meyer, E.L.; Baugues, K.A. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Jul 1989. 106p. (EPA–450/4-89/010). Source: NTIS, PC A06/MF A01.

The document describes how to account for transport of ozone or ozone precursors when using the Empirical Kinetic Modeling Approach (EKMA) or the Urban Airshed Model (UAM). Appendix A describes how to apply a Personal Computer (PC) computer program to determine backtrajectories using surface wind data.

51666 (PB–90-256405/XAB) **Guides to pollution prevention: The paint-manufacturing industry.** Jacobs Engineering Group, Inc., Pasadena, CA (USA). Jun 1990. 74p. Contract EPA-68-02-4286. Source: NTIS, PC A04/MF A01.

See also PB–90-192790.

Paint manufacturing facilities generate large quantities of both hazardous and nonhazardous wastes. These wastes are: equipment cleaning wastewater and waste solvent, filter cartridges, off-spec paint, spills, leftover containers; and pigment dusts from air pollution control equipment. Reducing the generation of these wastes at the source, or recycling the wastes on- or off-site, will benefit paint manufacturers by reducing raw material needs, reducing disposal costs; and lowering the liabilities associated with hazardous waste disposal. The guide provides an overview of the paint manufacturing processes and operations that generate waste and presents options for minimizing the waste generation through source reduction or recycling.

51667 (PB–90-256561/XAB) **Report on Region III's asbestos hotline. Technical report.** Lubick, L. Harvard Univ., Cambridge, MA (USA). John Fitzgerald Kennedy School of Government. 1989. 59p. Source: NTIS, PC A04/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The research project studies the effectiveness of an asbestos hotline that was created by Reg. III in June, 1989 through the cooperative efforts of the Air Enforcement Branch and Toxics and Pesticides Branch in Region III for use in the Annapolis, MD area. The hotline enables public officials to act upon confidential tips provided by citizens who are aware of potential asbestos

violations. The major thrust of the NNEMS project focuses on outreach activities-making the public aware of asbestos problems and of the Annapolis hotline as a tool to address their concerns. Diverse groups were targeted through press, radio, Congress and the public school system explaining the role citizens play in the control of asbestos. Subsequent citizen use of the hotline cited violations in public offices and manufacturing buildings, but did not produce reports of violations in school facilities. Apparently, school fliers failed to reach their target audience. Preliminary analysis indicates that the most effective method to publicize the hotline is through public service announcements on radio and in newspapers.

51668 (PB–90-256660/XAB) **Proposed VOC sampling network for a complex urban/industrial area: Fairfax sampling proposal. Technical report.** Thomas, M.J. Kansas Univ., Lawrence, KS (USA). Dept. of Civil Engineering. 1990. 34p. Source: NTIS, PC A03/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The study develops a sampling scheme for the Fairfax Industrial District located in Kansas City, Kansas. The Fairfax Industrial District is a complex urban/industrial area possessing a wide variety of VOC sources. The complexity of the site makes individual source monitoring and discrimination difficult with existing sampling networks. However, the addition of a sequential, multicollection sampler will improve existing sampling networks such that individual source contributions within a multiple VOC source environment can be identified and quantified. The overall objective of the study will be the development of a sampling protocol and design that is simple to operate and will allow a regulatory agency to monitor a given urban/industrial source with a reasonable degree of confidence. The objective will be developed using a four step procedure consisting of: a site characterization to collect and organize VOC emission and background information, VOC and micrometeorological data collection using the sequential, multicollector method, analysis and integration of resulting data using gas chromatography/mass spectrometry and back trajectory analysis, and an interpretation of resulting data using a discriminant matching technique.

51669 (PB–90-256702/XAB) **Influence of the Toxics Release Inventory on State air toxics control programs. Technical report.** McMurrer, D.L. Duke Univ., Durham, NC (USA). School of Forestry and Environmental Studies. 20 Dec 1989. 71p. Source: NTIS, PC A04/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The study assesses the influence that the Toxics Release Inventory (TRI) data has had on State air toxics control programs and suggests ways the Environmental Protection Agency (EPA) can assist the States in their use of the TRI data. The TRI data describes the environmental release and off-site transfers of hazardous chemicals by large U.S. manufacturing facilities. Nine states participated in the study: Alabama, California, Kansas, Louisiana, New York, Ohio, Rhode Island, Virginia, and Washington. Each state answered questions about how their program was influenced by the TRI reporting requirements and data. The results of the study indicate that the States' air toxics control programs have been influenced by the TRI data in three ways: (1) their workload has been increased; (2) their visibility has increased because of TRI related questions; and (3) some of their programs are being altered to incorporate use of the TRI data. The study concludes that the EPA can help the States make the most of the TRI data by: (1) enabling them to generate and respond to public attention quickly and easily; and (2) providing them models of how other States have used the TRI data to advance their air toxics control efforts.

51670 (PB–90-256736/XAB) **Reducing emissions through energy efficiency: Options for EPA action. Master's thesis.** Brown, J.B. Harvard Univ., Cambridge, MA (USA). John Fitzgerald Kennedy School of Government. Jul 1989. 47p. Source: NTIS, PC A03/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The EPA faces a fundamental policy dilemma. Electric energy conservation investments have been shown to be an effective means of reducing emissions. But, the EPA does not have the statutory mandate to play an active role in the decision-making processes which ultimately influence ratepayer and utility investments. However, the EPA can successfully promote conservation if it targets education and subsidies to energy conservation and awareness. The following recommendations utilize EPA's expertise and credibility to promote energy conservation. Special attention is focused on remaining within the parameters of the agency's statutory mission. (1) The EPA should launch a nationwide publicity campaign to promote the idea that investing in energy efficiency is a way to save the environment while saving money. (2) The EPA should fund curriculums researching environmental costs of electricity consumption and the environmental benefits of conservation. (3) The EPA should support legislative attempts to amend the Clean Air Act to require or suggest that least-cost emissions strategy be included in state implementation plans (SIPs).

51671 (PB–90-256777/XAB) **Procedures for applying city-specific EKMA. Final report.** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Jul 1989. 119p. (EPA–450/4-89/012). Source: NTIS, PC A06/MF A01.

See also PB–90-255415.

OZIPM-4 is a model which allows the user to estimate the volatile organic compound (VOC) control requirement for a city in order to achieve the national ambient air quality standard for ozone. The manual outlines the inputs required to run OZIPM-4 and explains how to develop the needed variables.

51672 (PB–90-258427/XAB) **American Combustion Pyretron destruction system. Applications analysis report.** Acurex Corp., Jefferson, AR (USA). Jun 1989. 54p. Contract EPA-68-03-3267. Source: NTIS, PC A04/MF A01.

See also PB–89-167894.

The report analyzes American Combustion's Pyretron oxygen enhanced burner system. The report discusses information on the economical advantages of this type of incineration for use in assessments at uncontrolled hazardous waste sites.

51673 (PB–90-258864/XAB) **Development of a state-of-the-art acid-deposition model for the South Coast Air Basin of California. Final report.** Pandis, S.N.; Seinfeld, J.H. California Inst. of Tech., Pasadena, CA (USA). 25 Mar 1989. 192p. Contract ARB-A732-043. Source: NTIS, PC A09/MF A01.

Three different aqueous-phase modules have been developed to describe the physicochemical processes associated with the aqueous-phase in the atmosphere. These modules constitute the central core of an urban-scale acid deposition model and can be incorporated into an Eulerian three dimensional grid-based system. The fog model (Module 2) has been implemented in a trajectory framework and has been employed to predict the temperature profile, fog development, liquid water content, gas and aqueous phase concentrations of pollutants, and wet deposition rates of main ionic species during the radiation fog episode in Bakersfield in the San Joaquin Valley of California over the period January 4-5, 1985.

51674 (PB–90-259649/XAB) **Measurements of toxic exhaust emissions from gasoline-powered light-duty vehicles. Final report.** Warner-Selph, M.A. Southwest Research Inst., San Antonio, TX (USA). Nov 1989. 192p. Contract ARB-A6-198-32. Source: NTIS, PC A09/MF A01.

Exhaust emission rates of selected toxic substances were determined for two gasoline-powered passenger cars. These substances, which have appeared on California Air Resources Board Toxic Air Contaminant list or have been candidates for the lists, include volatile and semi-volatile halogenated hydrocarbons, 1,3-butadiene, acrolein, phenols, nitrobenzene, dialkylnitrosamines, and a number of other unregulated emissions. Regulated gaseous emissions and fuel economy were also measured. A literature search was performed to determine if any of these compounds had previously been measured in the exhaust of gasoline-powered vehicles and if appropriate analytical procedures were available. When unavailable, procedures were developed for sampling and

analyzing the unregulated toxic emissions compounds. The two vehicles were then tested to determine the emission rates of the targeted compounds. In the tests, a 1987 Ford Taurus equipped with a 3-way plus oxidation catalyst and a 1986 Toyota Camry equipped with a 3-way catalyst only were operated over the Federal Test Procedure, the Highway Fuel Economy Test, and the New York City Cycle. The test fuel was a regular unleaded gasoline without ethanol or methanol, and was obtained from California.

51675 (PB–90-259854/XAB) **Minimization and control of hazardous combustion byproducts. Research report, February 1989-February 1990.** Dellinger, B.; Taylor, P.H.; Trey, D.A. Dayton Univ., OH (USA). Research Inst. Aug 1990. 399p. Source: NTIS, PC A17/MF A03.

The report describes the results of a research effort in which all relevant information regarding the minimization and control of hazardous combustion byproducts (Products of Incomplete Combustion, PICs) that result from operations in which hazardous waste is thermally destroyed (e.g., in incinerators, boilers and kilns) is summarized, analyzed and thoroughly described. The research was conducted cooperatively by the University of Dayton Research Institute (UDRI) and the EPA Risk Reduction Engineering Laboratory (RREL) under Cooperative Agreement CR813938-01-1. The report covers a period from February 1989 to February 1990.

51676 (PB–90-262817/XAB) **Building with low-emitting materials and products: Where do we stand. Report for March-July 1990.** Tucker, W.G. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1990. 9p. (EPA–600/D-90/106). Source: NTIS, PC A02/MF A01.

The paper gives three examples of material and product selection criteria, proposes emissions criteria for judging the acceptability of products, and discusses future directions in product testing for prevention of indoor air quality (IAQ) problems. One way to help ensure good IAQ is to use materials and products with low emissions of substances that can cause health or comfort problems. Over the past several years, research and development of product testing procedures and exposure prediction models have produced useful tools for evaluating the acceptability of building materials, furnishings, and other products used in buildings. Emission testing and prediction of occupant exposures has recently become a key step in the design of some major office building projects.

51677 (PB–90-262833/XAB) **Preliminary selection of refrigerants for dual-circuit and Lorenz refrigerator/freezers.** Bare, J.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1990. 17p. (EPA–600/D-90/104). Source: NTIS, PC A03/MF A01.

The paper discusses the preliminary selection of refrigerants for dual-circuit and Lorenz refrigerator/freezers (RFs). Since RFs currently use a fully halogenated chlorofluorocarbon (CFC) as a refrigerant and are the most energy-consuming appliances in most households in the U.S., EPA is concerned about not only RFs' effects on stratospheric ozone depletion but also their impact on the greenhouse effect. Reductions in power consumption will slow the increase in carbon dioxide (CO_2) concentrations in the atmosphere by reducing the utility companies' need for capacity. CO_2 concentrations are believed to be directly related to impacts of the greenhouse effect. For these reasons, EPA believes that finding the most energy-efficient refrigerant(s) and RF design is important when eliminating fully halogenated CFCs. Two new configurations (the dual-circuit and Lorenz RFs) appear to provide energy savings of up to 20% over standard U.S. RF designs.

51678 (PNL–7475) **The air quality monitoring program for the 1100-EM-1 remedial investigation.** Glantz, C.S.; Laws, G.L. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 173p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE91000081. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Air quality monitoring for the remedial investigation of the Hanford Site's 1100-EM-1 operable unit was conducted in the spring and fall of 1989 and during January 1990. The monitoring program was divided into two phases. The first phase examined the air quality impact of routine atmospheric emissions at three of the operable unit's waste sites before the beginning of intrusive remedial investigation activities. The second phase of monitoring examined the air quality impact of routine atmospheric emissions from two of the operable unit's waste sites during intrusive remedial investigation activities. Each phase of the program consisted of a series of monitoring events that measured pollutant concentrations at key locations upwind and downwind of individual waste sites. During each monitoring event, sampling was conducted to determine the air concentrations of a wide variety of volatile organic compounds and semivolatile organic compounds. Monitoring for heavy metals and asbestos was also conducted during some monitoring events. 8 refs., 15 figs., 9 tabs.

51679 (PNL-SA–18282) **Expert systems: A new approach to radon mitigation training and quality assurance.** Brambley, M.R.; Hanlon, R.L.; Parker, G.B. Pacific Northwest Lab., Richland, WA (USA). Jul 1990. 6p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. (CONF-900724–9: 5. international conference on indoor air quality and climate, Toronto (Canada), 29 Jul - 3 aug 1990). Order Number DE91000414. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Training radon mitigators and ensuring that they provide high-quality work on the scale necessary to reduce radon to acceptable levels in the large number of homes and schools requiring some mitigation is a challenging problem. The US Environmental Protection Agency and several states have made commendable efforts to train mitigators and ensure that they provide quality services to the public. Expert systems could be used to extend and improve the effectiveness of these efforts. The purpose of this paper is to introduce the radon community to this promising new technology. The paper includes a description of a prototype system developed by Pacific Northwest Laboratory that illustrates several of the capabilities that expert systems can provide, a brief explanation of how the prototype works, and a discussion of the potential roles and benefits of fully-developed expert systems for radon mitigation. 4 refs., 3 figs.

51680 (PTB-Ra–25) **Radionuclide concentration in ground-level air from 1988 to 1989 in North Germany and North Norway.** Kolb, W. Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Radioaktivitaet. Apr 1990. 30p. Source: Available from Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Radioaktivitaet.

The activity concentration of various fission products and some other radionuclides (e.g. Be-7, Na-22, K-40 and Pb-210) contained in ground-level air were determined by gamma-ray spectroscopy. The mean monthly activity concentrations of up to 19 radionuclides measured in 1988 and 1989 in Brunswick, Berlin and at 2 stations in North Norway (Skibotn and Vardoe) are tabulated. In 1989 the Cs-137 concentration in Brunswick was just 0.1% of that in 1986 but due to resuspended soil dust still 5 times higher than in 1985. Occasionally, fresh fission or activation products from other sources were detected such as La-140 (without Ba-140) late September 1988 and late October 1989 in Brunswick, or I-131 after the passage of a damaged Soviet submarine late June and early July 1989 in Vardoe. The effective dose equivalent due to the inhalation of fission products is estimated for all four sites to be less than 0.1% of the Pb-210 inhalation dose. (orig.).

51681 (SLAC–363) **[Stanford Linear Accelerator Center] annual environmental monitoring report, January–December 1989.** Stanford Linear Accelerator Center, Menlo Park, CA (USA). May 1990. 51p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE91000046. Source: NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This progress report discusses environmental monitoring activities at the Stanford Linear Accelerator Center for 1989. Topics include climate, site geology, site water usage, land use, demography, unusual events or releases, radioactive and nonradioactive releases, compliance summary, environmental nonradiological program information, environmental radiological program information, groundwater protection monitoring ad quality assurance. 5 figs., 7 tabs. (KJD)

51682 (STEV–1989-R27) **Flue gas condensing at combustion of wood fuels and peat: Technique, environmental effects, economy and potential.** Statens Energiverk, Stockholm (Sweden). Dec 1989. 43p. (In Swedish). Order Number DE91707876. Source: NTIS (US Sales Only), PC A03/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The main reason for condensation of flue gases from combustion are: * Heat extraction to improve profitability, * Reduction of dust- and gas emissions, * Improve the degree of self-supporting with indigenous fuels by extracting more heat from the limited resources of biofuels. Compared to conventional combustion 15-30% more heat can be extracted from a given volume of biofuels with flue gas condensation. From the environmental protection point of view, dust levels decreases with 70-90%, carbon dioxide with 15-30% and nitrogen oxides with 20-50%. All new wood fuel boilers, with more than 1 MW output power, ought to be equipped with flue gas condensation. (U.W.).

51683 (UCRL-JC–104134) **An updated summary of MATHEW/ADPIC model evaluation studies.** Foster, K.T.; Dickerson, M.H. Lawrence Livermore National Lab., CA (USA). May 1990. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9008157–1: ANS workshop on mechanistic analyses involving aerosols in non-reactor facility accidents, Salt Lake City, UT (USA), 2-3 Aug 1990). Order Number DE91000403. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper summarizes the major model evaluation studies conducted for the MATHEW/ADPIC atmospheric transport and diffusion models used by the US Department of Energy's Atmospheric Release Advisory Capability. These studies have taken place over the last 15 years and involve field tracer releases influenced by a variety of meteorological and topographical conditions. Neutrally buoyant tracers released both as surface and elevated point sources, as well as material dispersed by explosive, thermally bouyant release mechanisms have been studied. Results from these studies show that the MATHEW/ADPIC models estimate the tracer air concentrations to within a factor of two of the measured values 20% to 50% of the time, and within a factor of five of the measurements 35% to 85% of the time depending on the complexity of the meteorology and terrain, and the release height of the tracer. Comparisons of model estimates to peak downwind deposition and air concentration measurements from explosive releases are shown to be generally within a factor of two to three. 24 refs., 14 figs., 3 tabs.

51684 **Observational and theoretical studies of greenhouse climate effects.** Taylor, K.E. (Atmospheric and Geophysical Sciences Division, Lawrence Livermore National Laboratory, Livermore, CA (US)); Grotch, S.L. pp. 3-16 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper discusses quantitative estimates of future warming that could result from continued increases in greenhouse gas concentrations that come from sophisticated mathematical models, which are the modern climatologists' primary prognostic tool. The current limitations and uncertainties in these model results, however, prevent definitive predictions of the regional climatic responses that make up the projected global change. Deficiencies in the historical climate record prevent confirmation of the climate model predictions, but future research offers the potential for improved understanding.

51685 **Atmospheric carbon dioxide and the global carbon cycle: The key uncertainties.** Peng, T.H. (Environmental Sciences Division, Oak Ridge National Lab., TN (US)); Post, W.M.; DeAngelis, D.L.; Dale, V.H.; Farrell, M.P. pp. 17-38 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper discusses the biogeochemical cycling of carbon between its sources and sinks which determines the rate of increase in atmospheric CO_2 concentrations. The observed increase in atmospheric CO_2 content is less than the estimated release from fossil fuel consumption and deforestation. This discrepancy can be explained by interactions between the atmosphere and other global carbon reservoirs such as the oceans, and the terrestrial biosphere including soils. Research on global carbon cycle processes is addressed. The authors report that the oceans have been the most important sinks for CO_2 produced by man.

51686 **Infrared fiber optic sensors for the remote detection of hydrocarbons operating in the 3.3 to 3.36 micron region.** Matson, B.S. (Pacific Northwest Lab., Richland, WA (US)); Griffin, J.W. pp. 13-26 of Chemical, biochemical, and environmental fiber sensors: Volume 1172. Lieberman, R.A.; Wlodarczyk, M.T. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 318 DOE Contract AC06-76RL01830. (CONF-8909177–: O/E Fibers '89: meeting of the International Society for Optical Engineering, Boston, MA (USA), 5-8 Sep 1989).

A novel class of spectrochemical sensors for remote sensing of hydrocarbons is investigated. This class of sensors exploits the excellent near infrared transmission properties of commercial zirconium fluoride optical fibers that have only recently been available. Several different remote spectrochemical sensors are discussed which incorporate these IR transmitting fiber optics; they include a gas absorption cell, a photoacoustic cell, and an inexpensive FT-IR interface to a remote gas analysis cell. Design characteristics and experimental data on sensitivity and linearity are presented. Potential areas of application for the new class of sensors are also discussed.

51687 **Comparison of observed and predicted KR-85 air concentrations.** Yildiran, M. (Health and Safety Research Division, Oak Ridge National Lab., Oak Ridge, TN (US)); Miller, C.W. pp. 331-340 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper presents a computer code, ANEMOS, written to estimate concentrations in air and ground deposition rates for Atmospheric Nuclides Emitted from Multiple Operation Sources. This code uses a modified Gaussian plume equation. Output from ANEMOS includes annual-average air concentrations and ground deposition rates of dispersed radio nuclides and daughters. The authors report that to use the environmental transport model properly, some estimate of the models predictive accuracy must be obtained. To validate the ANEMOS model, one year of weekly average Kr-85 concentrations observed at 13 stations located 28 to 144 km distant from continuous point source at the Savannah River Plant (SRP), Aiken, South Carolina, have been used. There was a general tendency for the model to underpredict the observed air concentrations slightly.

51688 **Human development and carbon dioxide emissions: part 1. Background, reference projection and uncertainty analysis.** Edmonds, J. (Pacific Northwest Laboratory, Washington, DC (USA)); Darmstadter, J. *International Journal of Global Energy Issues (Switzerland)*, 2(1): 3-13 (1990).

Greenhouse gases are products of human activity, and their production has increased as industrial development has increased. Increased production of these gases, of which carbon dioxide is the most significant, has affected global temperature and climate. The nature of future climatic change will depend upon the rate of emission of greenhouse gases, the capacity of mechanisms for their removal from the atmosphere, and the interaction between the composition of the atmosphere and the climate. This article deals with the first of these factors: the rate of emission. This topic is split into consideration of the background to CO_2 emissions and the long-term trends in emissions from fossil fuels. 25 refs., 6 tabs., 3 figs.

51689 **Computer simulation of the global climatic effects of increased greenhouse gases.** Washington, W.M. (National Center for Atmospheric Research, Boulder, CO (US)); Bettge, T.W.; Meehl, G.A.; Yost, J.B. *International Journal of Supercomputer Applications (USA)*, 4(2): 5-19 (1990).

The global and seasonal distribution of surface air temperature and the temporal and spatial distributions of surface temperature change caused by increased CO_2 is shown. The geographical distribution of seasonally time-averaged atmospheric temperature difference due to the simulated hypothetical greenhouse warming

is shown with the surface soil-moisture changes superimposed in order to highlight their association.

51690 Laboratory studies of free radical reactions in cloudwater. Schwartz, S.E. (Brookhaven National Laboratory, Upton, NY (USA)); Weinstein-Lloyd, J. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 173-177 (1990). DOE Contract AC02-76CH00016. (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Despite the low fraction of the atmosphere occupied by clouds and the low fractional volume of clouds occupied by liquid water, reactions in cloudwater can be important pathways for chemical transformation of atmospheric trace gases. To address the concern with specific reference to H_2O_2 production by free radical reactions, we have undertaken a study in which the rate of change in H_2O_2 concentration is monitored in synthetic and authentic cloudwater in which $O_2(-I)$ radicals are produced at rates comparable to those expected upon transfer of HO_2 from interstitial cloud air to cloudwater.

51691 Model test of CCN-cloud albedo climate forcing. Ghan, S.J. (Lawrence Livermore National Lab., CA (USA)); Taylor, K.E.; Penner, J.E.; Erickson, D.J. III. *Geophysical Research Letters (American Geophysical Union) (USA),* 17(5): 607-610 (Apr 1990).

Cloud condensation nuclei (CCN) influence cloud albedo through their effect on the cloud droplet size distribution. A number of studies have evaluated the climatic impact of the CCN-cloud albedo feedback, but all have assumed that cloud distributions, cloud thicknesses, and cloud liquid water contents would remain constant as the climate adjusted. The authors have tested this assumption using the Livermore version of the National Center for Atmospheric Research (NCAR) Community Climate Model (CCM1). The results indicate that there are no significant compensating changes in cloud properties that would counteract the 1.7% global albedo increase resulting from a fourfold increase in marine CCN concentration. Furthermore, when ocean surface temperatures are decreased 4°C in a manner broadly consistent with the enhanced cloud albedos, they predict an increase in cloud fraction of 3.5% and a reduction in cloud altitude, leading to a positive feedback from clouds that would imply a climate impact roughly double that calculated from cloud droplet size distribution change alone.

51692 An intercomparison of measurements of aerosol elemental carbon during the 1986 carbonaceous species method comparison study. Hansen, A.D.A. (Univ. of California, Berkeley (USA)); McMurry, P.H. *Journal of the Air and Waste Management Association (USA),* 40(6): 894-895 (Jun 1990). DOE Contract AC03-76SF00098.

For 10 days in August, 1986, equipment from many different organizations was set up at a location in the suburban Los Angeles area for sampling carbonaceous pollutant species in all forms. The authors report here on the intercomparison of two quite dissimilar sampling and analysis methods for aerosol elemental carbon. The two methods being compared are: University of Minnesota - impactor samplers with one or more stages, backed up by a quartz fiber afterfilter; elemental carbon (EC) analysis by oxidation in helium over an MnO_2 catalyst; Lawrence Berkeley Laboratory - real-time measurements with aethalometer, an optical absorption technique on a continuously collecting quartz fiber filter. The good agreement between the results suggest that there may be an approach towards an acceptable measurement standard for this important atmospheric pollutant species.

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Refer also to citation(s) 50351, 50489, 50492, 50603, 50611, 50612, 50635, 50674, 50698, 50699, 50712, 51626, 51643, 51644, 51659, 51681, 51685, 51725, 51742, 51745, 51746, 51751, 51754, 51755, 51756, 51757, 51758, 51759, 51854, 51870, 51894, 52604

51693 (CHOA–89304ACC0387, pp. 1-14) **Clean-up of oil waste material contaminated soil.** Ignasiak, T. (Alberta Research Council, Devon, AB (Canada)); Carson, D.; Szymocha, K.; Pawlak, W.; Ignasiak, B. Canadian Heavy Oil Association (Canada). [1989]. (CONF-8911238–: Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association, Calgary (Canada), 14 Nov 1989; CE–03151). In *Heavy oil production and the environment.* vp. Source: Canadian Heavy Oil Association, 425, 808-4 Avenue S.W., Calgary, AB, CAN T2P 3E8. Prices: $35.00 CAN.

A process has been developed for clean-up of soil contaminated with various oily waste materials. The process utilizes coal as a cleaning agent, and is based on the principles of oil agglomeration with contaminants acting as the bridging liquids. In the procedure known as AGLOFLOAT, the contaminated soil is mixed with a coal-water slurry. The products, in form of the contaminant wetted coal microagglomerates, are separated by flotation from the clean soil. Attrition taking place in the tumbler, and the sorption capacity of the coal have a major effect on process performance. Bench-scale experiments have been conducted with samples contaminated with coal derived tar, heavy oil as well as oil spills. The contaminant concentration in the samples ranged from less than 1% to over 40%. The parameters investigated were temperature, contaminant/coal ratio, solids concentration, agitation and residence time. As a result of parametric studies a set of general process conditions was established. The AGLOFLOAT process appeared to be very effective in clean-up of contaminated samples. The residual tar remaining in the processed soil ranged from 0 to a few tenths of a percent. The effectiveness of the cleaning procedure appeared to be dependent on the composition of the contaminated samples and also on the particle size distribution of solids. The process is now being tested in a 6 tonne/day continuous facility. Economic analysis of this clean-up technology indicates that, subject to availability of coal on the clean-up site and utilization of the generate agglomerates, the process cost will vary from $13-49 per tonne of contaminated soil. 11 figs., 3 tabs.

51694 (CP/PQ–50) **The effects of acid precipitations on wetlands.** Anderson, J.M. Environment Canada, PQ (Canada). Conservation and Protection. Dec 1986. 49p. (MICROLOG–90-03122). Source: PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The effects of acid precipitation on wetlands have only recently become the focus of extensive research. This report summarizes the existing information on the sensitivity of wetlands to acid precipitation and provides recommendations for future research. The report consists of five major sections, starting with a review of the literature on the effects of acid precipitation on wetland hydrology, hydrochemistry, vegetation and wildlife. Current data is sparse, so it is only possible to approximate wetland sensitivity to acid precipitation. Preliminary criteria with which to rate wetland sensitivity to acid precipitation are presented. These criteria are developed and used to rank the major wetland classes in Canada. It has been determined that poor fens and poor swamps are the most sensitive to acidification. A summary of current research in eastern North America addresses the effects of acid deposition on wetlands. A peatland survey in Ontario is used as an example for a proposed regional evaluation of wetland acidification impacts. A summary and list of recommendations for further research are also included. In conclusion, literature shows that nutrient-poor wetlands are important captors of sulphate, nitrate and ammonia ions contained in acid rain; the amount of the acid deposits that can be assimilated without modifying the hydro-chemical requirements of these vulnerable wetlands would be limited. A list of definitions of the classes of wetlands existing in Canada is provided. 75 refs., 1 fig., 3 tabs.

51695 (DOE/BP/18966–3) **Ural-tweed bighorn sheep wildlife mitigation project: Final completion report.** Young, L. (Forest Service, Libby, MT (USA). Kootenai National Forest); Yde, C. Forest Service, Libby, MT (USA). Kootenai National Forest; Montana Dept. of Fish, Wildlife and Parks, Missoula, MT (USA). Jun 1990. 38p. Sponsored by U.S. DOE Office of Administration and Human Resource Management; U.S. DOE Bonneville Power Administration. DOE Contract AI79-84BP18966. Order Number DE91000191. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The results of habitat improvement project activities accomplished under contract #84–38 for bighorn sheep mitigation along Koocanusa Reservoir from September 1, 1984, through June 30,

1990, are reported here. Habitat treatments were applied to ten areas and covered 1100 acres. Treatments used were prescribed fire, slashing combined with prescribed fire, and fertilization. Several variations in season or intensity were used within the slashing and prescribed fire treatments. This project was coordinated with and complemented concurrent Kootenai National Forest habitat improvement activities. 15 refs., 2 figs., 3 tabs.

51696 (DOE/ER/60241–1) **Leaf exsertion, leaf elongation, and leaf senescence in Eriophorum vaginatum and Carex Bigelowii: Final report.** Shaver, G.R.; Yandow, T.; Laundre, J. Marine Biological Lab., Woods Hole, MA (USA). Ecosystems Center. [1990]. 59p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER60241. Order Number DE90014740. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Most of the common sedges of arctic vegetation show a pattern of leaf production in which the exsertion and elongation of new leaves is more or less simultaneous with the senescence of old leaves. The present study was designed to increase our understanding of the variability sequential leaf production by arctic sedges, and to determine some of the controls on that variability. We did this in two ways: first, we compared the sequential patterns of leaf growth and senescence in E. vaginatum with those of Carex Bigelowii Torr. at two tussock tundra sites near Toolik Lake on the North Slope of Alaska. Second, we compared the responses of leaf growth in these species in control and fertilized plots and in two microenvironments thought to differ sharply in nutrient availability and total productivity. 29 refs., 28 figs., 2 tabs.

51697 (DOE/ER/60547–1) **Measurement and apportionment of radon source terms for modeling indoor environments.** Harley, N.H. New York Univ., NY (USA). Dept. of Environmental Medicine. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60547. Order Number DE91000823. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

This research has two main goals; (1) to quantify mechanisms for radon entry into homes of different types and to determine the fraction of indoor radon attributable to each source and (2) to model and calculate the dose (and therefore alpha particle fluence) to cells in the human and animal tracheobronchial tree that is pertinent to induction of bronchogenic carcinoma from inhaled radon daughters.

51698 (ESP–90-04736) **Changes in the decline status of hardwood forests in Ontario, 1986 to 1987.** Ecological Services for Planning Ltd., Guelph, ON (Canada). Dec 1989. 229p. (MICROLOG–90-04736). Source: PC Ontario Ministry of the Environment, Public Information Centre, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

The Hardwood Decline Survey (HDS) was intended to assess the degree and extent of existing damage to selected hardwood forest sites in the Great Lakes-St. Lawrence and Deciduous Forest Regions of Ontario. The objective of the 1987 survey was to provide both a temporal and a spacial perspective on the changes in the condition of the hardwood resource in Ontario. This report documents the results of the reassessment of the province-wide HDS plots conducted in 1987. Other than the plots corresponding to areas of severe defoliation, average decline indices for 1987 were very similar to the results from the 1986 survey. For the majority (67%) of the non-defoliated plots, the decline indices changed less than one standard deviation. This suggests that decline index mapping is repeatable from year to year, and supports the validity of the assessment procedures used. Currently, 3.4% of the trees in the HDS plots are dead. Approximately 1.3% mortality has occurred since the 1986 survey. The strongest correlations of the mean decline indices for 1987 are with insect defoliation levels within the plots. There are no consistent patterns that are discernible with respect to wet sulphate deposition within the study area. There is a general trend for the northern Ontario plots to have a higher decline index than the plots located in southern Ontario. This is probably related to macroclimatic and soil differences. Within southern Ontario, the plots located in the highest pollution loading area (especially the Aylmer, Cambridge, and Niagara Districts) have higher decline indices than plots located in the central and eastern portions of southern Ontario, where climate and soil conditions are similar. 18 refs., 125 figs., 16 tabs.

51699 (IC–90/113) **Three frequency model for the retrieval of vertical profile of soil moisture through passive microwave remote sensing techniques.** Rao, K.S. (International Centre for Theoretical Physics, Trieste (Italy)); Rao, Y.S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 16p. Order Number DE91604139. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Three frequency model is developed for the retrieval of soil moisture vertical profile up to a depth of root zone based on statistical inversion technique coupled with apriori information on the general trend of soil moisture variations. The model has been tested with simulated data and experimental data. The model has the flexibility for operational implementation and online processing. (author). 14 refs, 6 figs.

51700 (INP–1388/AP) **NEWCROSS.BAS program 26 neutron group cross section library for geophysical applications.** Czubek, J.A. Institute of Nuclear Physics, Cracow (Poland). 1988. 36p. Order Number DE91604877. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

BASIC/IBM PC.

For the elements: H, B, C, N, O, F, Na, Mg, Al, Si, Cl, K, Ca, Ti, Cr, Mn, Fe, Ni and Pb a 26 neutron group library of cross sections has been calculated for energies ranging from 14 MeV down to 0.215 eV. The following cross sections have been calculated: SR(J) - removal, STR(J) -transport and SL(J,L) - slowing down from the energy group J down to the group J+L. These group cross sections have been calculated using the algorithms proposed by Kreft starting from the microscopic cross section library of Abagyan et al. The library is in the form of the program NEWCROSS.BAS written in BASIC for IBM PC microcomputers. This library is used to calculate the slowing down parameters of rocks using the programs SLOWDOWN.BAS, SLOWN1.BAS or SLOWN2.BAS. (author).

51701 (INP–1403/AP) **NEROTH.BAS program for rock thermal neutron parameter calculations.** Czubek, J.A. Institute of Nuclear Physics, Cracow (Poland). 1988. 51p. Order Number DE91604879. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

BASIC/IBM PC.

The paper describes the NEROTH.BAS program calculating the thermal neutron diffusion rock parameters averaged over the neutron spectrum: absorption cross section, diffusion coefficient and diffusion length. Besides the listing of the NEROTH.BAS program all formulae used to calculate these parameters are reported. The calculation is based on the microscopic neutron cross section data files created by another program THERCROS.BAS, which is also included in this report. The resulting output data can be stored on a disk and then retrieved by using the program REPROTH.BAS. The following input data are needed for the calculation: the elemental composition of the rock matrix, its mineralogical density, porosity, water saturation, brine salinity and the density of hydrocarbons. The calculation can be carried out with varying porosity, or water saturation index or brine salinity. The matrix elemental composition can be introduced into the calculation either in oxide form or as the content of particular elements. There are no technical limitations as concerns the elemental composition of the rock matrix. The results are also given for neutrons of velocity of 2200 m/s. (author).

51702 (INP–1412/AP) **Report to the International Atomic Energy Agency: Agency Research Contract No 4121/R2/RB.** Woznicka, U. (ed.). Institute of Nuclear Physics, Cracow (Poland). 1988. 32p. Contract 4121/R2/RB. Order Number DE91604140. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results of search done under the International Atomic Energy Agency Contract no 4121/R2/RB: "Measurement of the thermal neutron macroscopic absorption cross-section on small rock samples" at the Institute of Nuclear Physics during the period from July 1, 1987 to June 30, 1988 are presented. The report contains the determination of the correction curve based on the measurement of the solutions of H_3BO_3 (IRM) including the definite neutron parameter for plexiglass moderator; the theoretical approach to the application (as the external moderator) of teflon -

the material having lower thermal neutron absorption cross section than the typical rock material. (author).

51703 (LA–11941-MS) **Sigma Mesa: Background elemental concentrations in soil and vegetation, 1979.** Ferenbaugh, R.W.; Gladney, E.S.; Brooks, G.H. Jr. Los Alamos National Lab., NM (USA). Oct 1990. 22p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract W-7405-ENG-36. Order Number DE91000018. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In 1979, soil and vegetation samples were collected on Sigma Mesa to provide background data before construction on the mesa. Elemental data are presented for soil, grass, juniper, pinon pine, and oak. None of the data looks out of the ordinary. The purpose of the sampling program was to acquire, before any disturbance, a set of data to be used as background for future impact analysis. 6 refs., 2 figs., 7 tabs.

51704 (LBL–29128) **First-order kinetics-controlled multiple species reactive transport of dissolved organic compounds in groundwater: Development and application of a numerical model.** McNab, W.W. Jr. Lawrence Berkeley Lab., CA (USA). May 1990. 154p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE91000188. Source: NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Reactive chemical transport models developed over the past decade have generally relied on the assumption that local thermodynamic equilibrium is achieved at all times between aqueous species in a given system. Consequently, homogeneous aqueous systems characterized by a number of kinetically slow reactions, particularly problems involving organic species, cannot be satisfactorily modeled. In this study, we present a prototype computer model, KINETRAN, which is designed to handle kinetically-controlled homogeneous reactions in the aqueous phase, along with the transport of the various species involved, through geologic media. 31 refs., 53 figs., 10 tabs.

51705 (NAGRA-NTB–90-13) **Radionuclide chain transport with matrix diffusion and non-linear sorption.** Jakob, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Hadermann, J.; Roesel, F. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Feb 1990. 64p. Source: Available from Nagra, CH-5401 Baden, Switzerland.

The present paper describes a two-dimensional model for radionuclide transport in inhomogeneous rock. Advective and dispersive flux takes place in water conducting zones which may consist of a network either of tubelike veins or planar fractures. Out of these flowpaths nuclides diffuse into stagnant pore water of a spatially limited, adjacent zone (matrix diffusion). Sorption on rock surfaces is described by a non-linear isotherm. Under specific conditions matrix can be represented by an effective (non-linear) surface sorption. Radioactive decay and, in the case of a nuclide chain, ingrowth is also included in the model . The numerical solutions of transport equations based on the method of lines are developed in detail. The advantages of this approach are the efficiency, the reliability and the general flexibility especially to include arbritary boundary and initial conditions and arbitrary solute/rock interactions. For Cs-135 we present in a comprehensive sensitivity analysis the impact of non-linear (Freundlich) sorption isotherm on break-through curves. It is shown that, provided transport times are comparable or larger than nuclide half-life, non-linear sorption may reduce concentrations at the geosphere outlet by orders of magnitude. Some results are also given for the transport. (author) 25 figs., 27 refs.

51706 (NUREG–0837-Vol.10-No.2) **NRC TLD [thermoluminescent dosimeter] Direct Radiation Monitoring Network: Progress report, April–June 1990: Volume 10, No. 2.** Struckmeyer, R.; McNamara, N. Nuclear Regulatory Commission, King of Prussia, PA (USA). Region I. Sep 1990. 222p. Sponsored by Nuclear Regulatory Commission. Source: NTIS, PC A10/MF A01 - GPO; OSTI; INIS.

This report provides the status and results of the NRC Thermoluminescent Dosimeter (TLD) Direct Radiation Monitoring Network. It presents the radiation levels measured in the vicinity of NRC licensed facilities throughout the country for the second quarter of 1990.

51707 (PB–90-234725/XAB) **Response to comments background document for the Third Third land-disposal restrictions proposed rule November 22, 1989, (54 FR 48372).** ICF, Inc., Fairfax, VA (USA). 8 May 1990. 1002p. Source: NTIS, PC EE99/MF E99.

Set includes PB–90-234733 through PB–90-234758. Portions of this document are not fully legible.

A separate abstract is included for each of 4 volumes of this set.

51708 (PB–90-234733/XAB) **Response to comments background document for the Third Third land-disposal restrictions proposed rule November 22, 1989 (54 FR 48372). Volume 2-1. Capacity-related comments.** ICF, Inc., Fairfax, VA (USA). 8 May 1990. 406p. Source: NTIS, PC A18/MF A03.

See also Volume 2-2, PB–90-234741. Portions of this document are not fully legible. Waste.; Also available in set of 3 reports, PC E99/MF E99, PB–90-234725.

On November 22, 1989, the Environmental Protection Agency (EPA, the Agency) proposed a rule to prohibit the land disposal of the final third of the schedule of restricted hazardous wastes, known as the Third Third (see 54 Federal Register 48372). The proposal outlined treatment standards and effective dates of prohibition for these wastes as well as for some First and Second Third soft hammer wastes, characteristic wastes, certain waste groups (e.g., multi-source leachate, radioactive mixed waste), and newly listed wastes. The proposed rule was issued pursuant to the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). The Agency requested public comment on the proposal. The regulated community, environmental organizations, trade associations, State and Federal agencies, and concerned citizens submitted over 300 written letters on the proposed rule. EPA developed three volumes of a comment response document. This document (Volume 2 of 3) presents a summary of and responses to capacity-related comments received by the EPA docket clerk in response to the proposed rule. The comments have been divided into 17 chapters, each addressing specific comment categories. This volume covers Chapters 1-7. The chapters discuss combustion, ignitable wastes, reactive wastes, arsenic, selenium, and lead wastes.

51709 (PB–90-249640/XAB) **Policy for Superfund compliance with the RCRA land-disposal restrictions. Directive (Final).** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 17 Apr 1989. 12p. (EPA–9347.1-02). Source: NTIS, PC A03/MF A01.

The directive assists the regional removal and remedial staff in making current site decisions about the Land Disposal Restrictions (LDR). The memorandum explains: (1) how to determine when LDRs are applicable to a Superfund removal or remedial action, and (2) the Superfund approach for complying with the LDRs when they are determined to be applicable.

51710 (PB–90-256686/XAB) **Some major factors important in establishing land-use policy for remediated Superfund sites. Technical report.** Crow, S.R.; Cooley, J.L. Georgia Univ., Athens, GA (USA). Dec 1989. 54p. Source: NTIS, PC A04/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. No explicit federal policy addresses future land use of remediated Superfund sites. The EPA has no official land use policy for these sites and most states have no mechanisms for identifying uncontrolled hazardous waste sites, and no policies or procedures for guiding redevelopment of remediated sites. Historically, land use decisions have been made by local governments. However, local governments are subject to political pressures which impact land use decisions, and may override environmental and health concerns. Thus, federal and state participation is vital in devising land use controls. In the absence of formal policy, a variety of factors impact land use decisions. Four general concerns are scientific uncertainty and technological limitations, cleanup standards and risk assessment, institutional controls, and liability

for remediation costs. The report concludes that the principal goal of land use policy should be to allow the most effective allocation and utilization of available resources to meet the legislative purpose of health and environmental protection. Various possible land use policy objectives are proposed.

51711 (PB–90-259961/XAB) **Biological treatment of soils containing manufactured gas plant residues. Topical report, June 1988-February 1990.** Cushey, M.A.; Morgan, D.J. Remediation Technologies, Inc., Pittsburgh, PA (USA). 11 May 1990. 152p. Contract GRI-5086-254-1334. Source: NTIS, PC A08/MF A01.

The report summarizes the results of an on-going laboratory research program directed by GRI to investigate the feasibility of using biological treatment to remediate soils containing residues from manufactured gas plant (MGP) sites, and to develop and verify a rapid assessment protocol (the GRI Accelerated Treatability Protocol) for determining the potential for biologically treating specific MGP site soils. This protocol, which features soil characterization, desorption testing and slurry reactor testing, is cost competitive with traditional treatability studies and can be completed in approximately half the time. For the first two soils evaluated, total polynuclear aromatic hydrocarbon (PAH) concentrations (a critical class of chemicals at MGP sites) were reduced by 95 and 80 percent to residual plateau concentrations of less than 10 and 5,000 mg/Kg, respectively. It is believed that the magnitude of the plateau concentration is not primarily dictated by the availability of nutrients, oxygen and adequate microbial populations but rather by limitations of mass transfer from the soil-waste matrix to the bulk aqueous phase. Further tests with thirteen other MGP soils are in-progress and the results of these will be reported at a later time.

51712 (PB–90-260118/XAB) **Health assessment for W. R. Grace and Co., Inc./Wayne Interim Storage Site, Wayne, Passaic County, New Jersey, Region 2. CERCLIS No. NJD891837980. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Jul 1990. 17p. Source: NTIS, PC A03/MF A01.

The Wayne Interim Storage Site (WISS) a Superfund site, was formerly owned and operated by the W.R. Grace Company, which used the site for the extraction and concentration of thorium from monazite ore. Off-site contamination occurred via soil transport during storm run-off to drainage areas. The main contaminants at WISS are radionuclides in the thorium-232 and uranium-238 decay series. The site is currently owned by the United States Department of Energy. Large sections of vicinity properties were remediated (excavated) to Department of Energy (DOE) radiological standards from 1985 through 1987. The WISS was prepared to serve as an interim site for the storage of low level radioactive soil. Radioactive materials remain on the WISS and railroad spur area. This site is considered to be of potential public health concern by ATSDR and NJDOH. This site is not presently being considered for follow-up health study or evaluation.

51713 (PB–90-262122/XAB) **Transuranium elements. Volume 2. Technical basis for remedial actions.** Burley, G. Office of Radiation Programs, Washington, DC (USA). Jun 1990. 123p. (EPA–520/1-90/016). Source: NTIS, PC A06/MF A01.

See also Volume 1, PB–90-262114.

The report consists of two volumes and addresses the problem of environmental contamination by plutonium and other transuranium elements. Volume 2 presents the general background relevant to developing criteria for site-specific remedial action options. The information is intended to provide an overall perspective on the considerations necessary for the decision-making process.

51714 (SKB-TR–90-05) **Potential effects of bacteria on radionuclide transport from a Swedish high level nuclear waste repository.** Pedersen, K. (Univ. of Gothenburg, Dept. of General and Marine Microbiology (Sweden)). Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Jan 1990. 64p. Order Number DE91604134. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Microorganisms can influence radionuclide migration if their concentration are high in comparison with other organic particles. Data on the numbers of microorganisms in undisturbed ground-water have been collected. The average number of cells in the samples from 17 levels in 5 boreholes was 3.0×10^5 cells ml^{-1}. A biofilm experiment indicated an active microbial rock surface population. Radiographic uptake experiments suggest inactive bulk water populations. The bulk water microbial cells in deep ground water might then be inactive cells detached from active biofilms. Enrichment cultures for anaerobic bacteria demonstrated the presence of anaerobic bacteria capable of growth on C-1 compounds with hydrogen and carbon dioxide, presumably methanogenic bacteria. Further, growth in enrichment cultures with sulphate as electron-acceptor and lactate as carbon source proved dissimilatory sulphate reducing bacteria to be present. (author).

51715 (SKB-TR–90-06) **Transport of actinides and Tc through a bentonite backfill containing small quantities of iron, copper or minerals in inert atmosphere.** Albinsson, Y. (Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Nuclear Chemistry); Saetmark, B.; Engkvist, I. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Apr 1990. 78p. Order Number DE91604135. Source: NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

In the Swedish concept for final disposal of high-level radioactive waste, compacted bentonite has been proposed as a suitable backfill. In order to study the possible effects of different additions to the clay on the transport of REDOX-sensitive nuclides an investigation has been performed where small quantities of iron or copper in different oxidation states or minerals have been added to the clay. The apparent diffusivity (D_a) of the actinides U, Pu, Np and the fission product Tc in compacted bentonite mixed with 1% Fe(0), Fe(II), Cu(0) or Cu(II) and for Np and Tc with 1 or 10% respectively of vivianite ($Fe_3(PO_4)_2$), magnetite or fracture fillings (mainly epidot and chlorite) has been measured in an inert nitrogen atmosphere. The results indicate, especially in the case of Fe(0) or Fe(II), reduction from the higher oxidation states Np(V), U(VI) and Tc(VII) probably to Np(IV), U(IV) and Tc(IV). D_a is reduced by several orders of magnitude, and for Tc with Fe(0) addition no migration could be measured ($D_a < 2x10^{-16}$ m^2/s) while in the case of Cu(I) the effect is not so pronounced. ($D_a = 2x10^{-11}$ m^2/s) U and Np show the same trend. For plutonium no diffusion can be measured in the time scale used. For the minerals no change in diffusion rate was achieved in the case of 1% addition of the minerals. However, for Tc with addition of 10% of the minerals and long preequilibration time, especially for magnetite and fracture fillings, indication of reduction is pronounced. Further experiments with Pu are still in progress due to long contact times.

51716 **Horizontal wells for in-situ remediation of groundwater and soils.** Kaback, D.S. (E.I. du Pont de Nemours and Co., Aiken, SC (USA)); Looney, B.B.; Corey, J.C.; Steele, J.L.; Wright, L.M. III. pp. 121-135 of The proceedings of the third national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods. National Water Well Association, Dublin, OH (US) (1989). pp. 1161 (CONF-8905127–: 3. National Water Well Association outdoor action conference, Orlando, FL (USA), 22-25 May 1989).

Two horizontal wells were installed adjacent to an abandoned process sewer line at the Savannah River Plant. Documented leaks from the process sewer have contaminated the underlying vadose zone and ground water with volatile organic compounds. The wells were installed to test new methods of in-situ remediation of soils and ground water. A deep horizontal well, installed below the water table, is to be used as an air-injection well to strip volatile organics from the contaminated ground water. The shallow horizontal well, installed in the vadose zone, is to be used to remove vapor-phase volatile organic compounds from the vadose zone and to recover the organics purged from the ground water.

51717 **Energy and radiative precursor emissions.** Edmonds, J.A. (Pacific Northwest Laboratory, Washington, DC (US)); Wuebbles, D.L.; Scott, M.J. pp. 353-370 of Environmental problems and solutions: Greenhouse effect, acid rain, pollution. Veziroglu, T.N. Hemisphere Publishing, New York, NY (USA) (1990). pp. 525

This paper discusses the timing and magnitude of climatic change, the greenhouse issue, which depends on both man-made emissions and natural processes. Energy production, transformation, end-use and conservation are associated with emissions of many of the key radiatively important gases (RIG's). The authors

address the link between energy use and Co_2. Scenarios of future atmospheric composition sued in climate studies are studied. Crude calculations are presented to examine the potential uncertainty with regard to radiative forcing which could be narrowed by further research in the areas of endogenous emissions and atmospheric chemistry.

51718 **Chemical confinement systems for waste disposal.** Rivera, A.L. (Oak Ridge National Laboratory, TN (USA)); Jolley, R.L. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 61-64 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

The overall objective of waste disposal systems is for long-term isolation of the waste. A waste confinement system can be developed as a three-step management strategy: (1) waste processing and packaging prior to disposal with the objective of immobilizing the contaminant, (2) selection and construction of engineered barriers to prevent or control the migration of the contaminant from the disposal unit, and (3) selection of a disposal site having appropriate hydrogeolic properties with the objective of using natural barriers to control the migration of waste contaminant from the disposal facility.

51719 **Transport of dissolved organic matter and polychlorinated biphenyls in soil columns.** Dunnivant, F.M. (Oak Ridge National Laboratory, TN (USA)); Jardine, P.M.; Taylor, D.T.; McCarthy, J.F. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 407-410 (1990). DOE Contract AC05-84OR21400. (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Numerous investigations have shown that naturally-occurring dissolved organic matter (DOM) increases the apparent solubility of hydrophobic pollutants, such as polychlorinated biphenyls (PCBs). Recently, groundwater surveys have documented the enhanced transport of contaminants as compared to equilibrium convective dispersive model predictions. The purpose of this investigation was to experimentally determine the transport of dissolved organic material (DOM) in laboratory soil columns and evaluate the hypothesis of co-transported hydrophobic contaminants.

51720 **Mourning dove use of man-made ponds in a cold-desert ecosystem in Idaho.** Howe, F.P. (South Dakota State Univ., Brookings (USA)); Flake, L.D. *Great Basin Naturalist (USA),* 49(4): 627-631 (31 Oct 1989).

Mourning doves (Zenaida macroura) in a cold-desert ecosystem used man-made ponds for watering, feeding, gritting, loafing, and courting. Diurnal pond use by doves peaked in the morning and evening. Monthly dove use of ponds fluctuated slightly during the summers of 1984 and 1985. Pond size, pH, and shoreline characteristics had little association with the intensity of pond use by doves; but geographic isolation of ponds was weakly associated had pond-use intensity. The number of doves present at the beginning of the one-hour period was a poor indicator of the number of arrivals during that period. We conclude that man-made water sources are important in areas where water availability may limit mourning dove productivity and abundance. It is suggested that mourning dove arrival rates could be used as a population index in cold-desert areas.

51721 **Persistence and distribution of PCBs in the sediments of a reservoir (Lake Hartwell, South Carolina).** Dunnivant, F.M. (Oak Ridge National Laboratory, TN (USA)); Polansky, A.L.; Elzerman, A.W. *Bulletin of Environmental Contamination and Toxicology (USA),* 43(6): 870-878 (Dec 1989).

PCBs are one of the most persistent and ubiquitous pollutants occurring in the environment today. Since their release to the environment, PCBs have been found in water, air, soil, sediment, and human samples. Low levels are now identifiable even in remote sites. Once in aquatic systems, PCBs tend to associate with particulate matter which may subsequently settle to the bottom. Thus, lake and river sediments have been found to be a major PCB sink in aquatic systems, as observed for the reservoir system studied here. Lake Hartwell is a PCB-contaminated reservoir located in the upper Savannah River basin in South Carolina and Georgia. It has received the majority of the PCB contamination from Twelve-Mile River, a major tributary at the top of the reservoir located in the northwestern portion of South Carolina in Pickens County. The purpose of this investigation was to provide information on the lake-wide fate and distribution of PCBs and effects of natural and anthropogenic redistribution processes. Although congener-specific data were generated, space for only total PCB concentrations is available here.

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Refer also to citation(s) 50274, 50351, 50486, 50491, 50598, 50600, 50614, 50620, 50650, 50691, 50692, 50693, 50694, 50695, 50696, 50697, 50699, 50700, 50701, 50702, 50703, 50704, 50705, 50915, 50951, 50989, 51094, 51643, 51644, 51659, 51666, 51681, 51694, 51706, 51713, 51716, 51837, 51854, 51891, 51894, 52604

51722 (AD-A–223438/3/XAB) **Installation-Restoration Program Stage 5. Informal technical information report, analytical data summary. Preliminary pathways assessment - surface-water and stream-sediment samples. Final report, January 1989-March 1990.** Radian Corp., Sacramento, CA (USA). 17 May 1990. 178p. Contract F33615-87-D-4023. Source: NTIS, PC A09/MF A01.

This letter report presents the analytical results and data evaluation for surface water and stream sediment sampling performed at McClellan AFB in January and February, 1989. Results are also provided from a geophysical investigation that was performed to locate possible underground storage tanks at five locations on McClellan AFB. All work was performed in accordance with the Draft Preliminary Pathways Assessment Work Plan, September 1988. Information obtained during this preliminary investigation, indicates that manufactured organic compounds and metals exist in some of the creeks and drainages at McClellan AFB. The data indicate that low-level contamination potentially originates from both on-base and off-base sources. Results from the geophysical investigation indicated a low probability of having underground storage tanks at three locations. Two of the five locations investigated were identified as having a high probability of having underground tanks.

51723 (ANL/EAIS/TM–28) **Hydrological conditions at the 317/319 Area at Argonne National Laboratory.** Patton, T.L.; Pearl, R.H.; Tsai, S.Y. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Aug 1990. 89p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE91000099. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This study examined the hydrological conditions of the glacial till underlying the 317/319 Area at Argonne National Laboratory (ANL) near Lemont, Illinois. The study's purpose was to review and summarize hydrological data collected by ANL's Environment, Safety, and Health Department and to characterize, based on these data, the groundwater movement and migration of potential contaminants in the area. Recommendations for further study have been made based on the findings of this review. The 317/319 Area is located between Meridian Road and the southern border of ANL. The 317 Area was commissioned in the late 1940s for the temporary storage of radioactive waste. Low- and high-level solid radioactive waste is stored in partially buried concrete vaults. Low-level radioactive waste awaiting shipment for off-site disposal is stored in aboveground steel bins north of the vaults. The 319 Area is an inactive landfill, located east of the 317 Area that was used for the disposal of general refuse, demolition debris, and laboratory equipment. Fluorescent light bulbs, chemical containers, and suspect waste were also placed in the landfill. Liquid chemical wastes were disposed of at each site in gravel-filled trenches called "French drains." The 317/319 Area is underlain by a silty clay glacial till. Dolomite bedrock underlies the till at an average depth of about 19.5m. Organic contaminants and radionuclides have been detected in groundwater samples from wells completed in the till. Fractures in the clay as well as sand and gravel lenses present in the till could permit these contaminants to migrate downward to the dolomite aquifer. At the time of this report, no chemical quality analyses had been made on groundwater samples from the

dolomite. The study found that existing information about subsurface characteristics at the site is inadequate to identify potential pathways for contaminant migration. 14 refs., 13 figs., 6 tabs.

51724 (ANL/EAIS/TM–29) **Hydrological conditions at the 800 Area at Argonne National Laboratory.** Patton, T.L.; Pearl, R.H.; Tsai, S.Y. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Aug 1990. 113p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE91000100. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This study examined the hydrological conditions of the glacial till underlying the 800 Area sanitary landfill at Argonne National Laboratory (ANL) near Lemont, Illinois. The study's purpose was to review and summarize hydrological data collected by ANL's Environment, Safety, and Health Department and to characterize, on the basis of these data, the groundwater movement and migration of potential contaminants in the area. Recommendations for further study have been made based on the findings of this review. The 800 Area landfill is located on the western edge of ANL, just south of Westgate Road. It has been in operation since 1966 and has been used for the disposal of sanitary, general refuse. From 1969 through 1978, however, substantial quantities of liquid organic and inorganic wastes were disposed of in a "French drain" at the northeast corner of the landfill. The 800 Area landfill is underlain by a silty clay glacial till. Dolomite bedrock underlies the till at an average depth of about 45.6 m. Trace levels of organic contaminants and radionuclides have been detected in groundwater samples from wells completed in the till. Fractures in the clay as well as sand and gravel lenses present in the till could permit these contaminants to migrate downward to the dolomite aquifer. When this report was prepared, no chemical quality analysis have been made on groundwater samples from the dolomite. The study found that existing information about subsurface characteristics at the site is inadequate to identify potential pathways for contaminant migration. Recommended actions include installation of five new well clusters and one background well, thorough record-keeping, sample collection and analysis during borehole drilling, slug testing to measure hydraulic conductivity, topographic mapping, continued monitoring of groundwater levels and quality, and monitoring of the unsaturated zone. 17 refs., 13 figs., 4 tabs.

51725 (CONF-9005271–1) **USDOE applied R&D private sector initiatives.** Lien, S.C.T. (USDOE Office of Environmental Restoration and Waste Management, Washington, DC (USA). Office of Technology Development); Borys, S.S.; Erickson, M.D. Argonne National Lab., IL (USA). [1990]. 13p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract W-31109-ENG-38. From 1990 conference on hazardous waste research; Manhattan, KS (USA); 21-22 May 1990. Order Number DE90017658. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Department of Energy (DOE) has recently consolidated its Environmental Restoration and Waste Management activities. Within that new organization, DOE has committed to conduct Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) activities within the Office of Technology Development (OTD) to reduce cost, reduce risk, and otherwise improve the technologies to meet its cleanup goals. Currently available technology is not adequate to assess environmental contamination, take permanent remedial action, and to eliminate or minimize the environmental impact of future operations. To focus private sector capabilities on the high-priority needs of DOE, a series of competitive solicitations will be issued starting in FY 1990. This paper describes the range and scope of the DOE initiatives for private sector involvement in Applied R&D. 2 tabs.

51726 (CONF-9009254–1) **Calibration of groundwater flow models using Monte Carlo simulations and geostatistics.** Hoeksema, R.J. (Calvin Coll., Grand Rapids, MI (USA)); Clapp, R.B. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on calibration and reliability in groundwater modeling; Hague (Netherlands); 3-6 Sep 1990. Order Number DE90017737. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Groundwater flow models require specification of several input parameter fields which are inferred from limited data. In this paper the hydraulic conductivity and recharge rate are estimated for an unconfined aquifer under steady flow conditions. Usually point observations of conductivity and head are available for the estimation of the distributed conductivity field and the recharge rate. Use of numerical flow models require that these fields be prescribed as average values over finite elements. The geostatistical solution to this problem uses linear estimation to obtain the distributed conductivity field and the recharge rate. Monte Carlo simulations are used here to compute the covariances associated with the head data. Results obtained for both artificial and real data show that the head data is effective in improving the estimates that would result using conductivity data alone. The use of Monte Carlo simulations results in a method which can be used under a wider variety of modeling conditions than previous applications of the geostatistical approach. 11 refs., 2 figs.

51727 (DOE/ER/60269–T2) **Coordination for the OHR/ERD R4D program: Final report.** Kelley, J.J. Alaska Univ., Fairbanks, AK (USA). Inst. of Marine Science. May 1990. 567p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-84ER60269. Order Number DE90015523. Source: NTIS, PC A24/MF A01 - OSTI; GPO Dep.

This report is a final report for Grant No. FG06-84ER-60269. This project provided coordination in the field for the R4D projects and climatological services. It consisted of: scheduling and logistics coordination services, Liaison services with industry, government and academic institutions, and Technical Services in the field as requested (regional climatology, atmospheric particulate input). A research site was chosen in summer 1984 as the intensive watershed research area for the R4D program. This research site is on TransAlaska pipeline corridor property (MS-117) permitted to the Alyeska Pipeline Company by the US Bureau of Land Management. Permission to enter this land for the purpose of carrying out scientific research requires permission from a variety of state and federal agencies and the local government. Permission to use the material site (MS-117) was granted by the Alyeska Pipeline Company.

51728 (DOE/ER/60850–1) **[The role of natural organic matter in the partitioning and transport of polynuclear aromatic hydrocarbons in groundwater]: Progress report.** Colorado Univ., Boulder, CO (USA). [1990]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60850. Order Number DE91000826. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

A general summary of our progress associated with batch and column experiments is included in this report. During the period of July 1, 1989 through the present, we have emphasized batch experiments to study the partitioning between one PAH, phenanthrene, and each of two sources of groundwater natural organic matter (NOM) in the presence and absence of a model mineral surface (a-Al_2O_3). The behavior of a soil-derived fulvic acid sorbed to the mineral surface has also been investigated. The NOM sources were used as "bulk" (unfractionated) and fractionated into different molecular weight (MW) fractions by ultrafiltration (UF), and into humic and non-humic fractions by XAD-8 resin adsorption. Three techniques have been evaluated for differentiating between aqueous PAH and NOM-bound PAH: fluorescence quenching (FQ), reverse phase (Sep-Pak) separations, and dialysis bags. We have conducted batch experiments to study the three binary systems; PAH-NOM, PAH-a-Al_2O_3, and NOM-a-Al_2O_3; and the ternary system, PAH-NOM-a-Al_2O_3. Sorption of NOM onto a mineral surface, alumina, has been evaluated from the perspective of providing a model of soil organic matter.

51729 (DP-MS–88-169) **Wetlands mapping with spot multispectral scanner data.** Mackey, H.E. Jr. (Savannah River Lab., Aiken, SC (USA)); Jensen, J.R. Savannah River Lab., Aiken, SC (USA). [1989]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00001. (CONF-8904117–2: American Society for Photogrammetry and Sensing/American Congress on Surveying and Mapping Auto-Carto 9 annual convention, Baltimore, MD (USA), 2-7 Apr 1989). Order Number DE91000780. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Government facilities such as the US Department of Energy's Savannah River Plant (SRP) near Aiken, South Carolina, often use remote sensing data to assist in environmental management. Airborne multispectral scanner (MSS) data have been acquired at SRP since 1981. Various types of remote sensing data have been used to map and characterize wetlands. Regional Landsat MSS and TM satellite data have been used for wetlands mapping by various government agencies and private organizations. Furthermore, SPOT MSS data are becoming available and provide opportunities for increased spacial resolution and temporal coverage for wetlands mapping. This paper summarizes the initial results from using five dates of SPOT MSS data from April through October, 1987, as a means to monitor seasonal wetland changes in freshwater wetlands of the SRP. 11 refs., 4 figs.

51730 (FO/CAR–779) **Marine ichthyoplankton data from the Canadian Beaufort Sea Shelf, July and September 1984.** Canadian data report of fisheries and aquatic sciences, No. 779. Chiperzak, D.B.; Hopky, G.E.; Lawrence, M.J.; Lacho, G. Canadian Pulp and Paper Association, Montreal, PQ (Canada). Technical Section. Feb 1990. 53p. (MICROLOG–90-04052). Source: PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

As part of the Beaufort Shelf Fish Habitat Research Subproject of the Northern Oil and Gas Action Program, ichthyoplankton were collected from 760 μm Wiscosin net and 500 μm neuston net plankton tows in July and September of 1984 along the Canadian Beaufort Sea Shelf. A total of 1408 larval fish representing six families and nine species groups were caught in the 34 plankton tows. Arctic cod (Boreogadus saida) was the most abundant larval fish species caught both in the Wisconsin and neuston tows. Standard length, total length, and wet-weight measurements were made on 1123 larval fish of which 1097 were Arctic cod. The July mean standard length for Arctic cod was 13.4 mm with a standard deviation of 2.7 mm, and a mean weight of 0.015 g with a standard deviation of 0.010 g. In September, Arctic cod mean standard length was 26.3 mm, standard deviation of 3.8 mm, and the mean weight was 0.130 g with a standard deviation of 0.058 g. A total of 126 fish were analyzed for stomach contents of which four were found to be empty. Copepods were the most frequently occurring food item in all four species groups analysed with Calanoida being the most frequently occurring and the most abundant food item for both B. saida and the fourhorn sculpin, Myoxcephalus quadricornis. Nine stomachs, all from B. saida, contained the parasite (Trematoda: Hemiuridae). 10 refs., 2 figs., 25 tabs.

51731 (FO/S–1171) **A survey of dilute lakes on the south coast of insular Newfoundland in relation to natural and anthropogenic acidification.** Canadian techical report of fisheries and aquatic sciences, No. 1711. Scruton, D.A.; Taylor, D.H. Department of Fisheries and Oceans, St. John's, NF (Canada). Science. Oct 1989. 67p. (MICROLOG–90-04323). Source: PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

In July 1983, a synoptic survey of the water chemistry of 90 lakes on the south coast of insular Newfoundland was undertaken to address sensitivity to and effects from the long range transport of air pollutants. Study lakes were characterized by very low alkalinities and acidic pH values. Lakes ranged from clear to high colored. Lake (excess) sulphate levels were also low, while organic anion levels range widely. Lake acidity reflected the inputs of both anthropogenic and natural acids. The dilute and acid-sensitive nature of the south coast lakes was confirmed by various sensitivity indices. A deficit in alkalinity was apparent in all but 2 lakes. A plot of south coast data on Henriksen's empirical acidification models suggests that most lakes showing acidification effects are strongly influenced by natural organic acidity. The acid-base balance in lakes in the southwest was more clearly related to anthropogenic sulfate levels. Both models are considered poor in their application to south coast lakes due to the preponderance of weak (organic) acid dominated systems. The ratios of alkalinity to excess Ca and Mg, excess sulfate to excess Ca and Mg, and alkalinity to excess sulfate for the study lakes provides further evidence of extreme sensitivity to acidification. The Wright-Henriksen acidification equation was used to predict pH/alkalinity values for the study lakes. This model suggested a 50% increase in sulfate deposition could result in 32% of south coast lakes becoming acidified, while a doubling of current sulfate deposition rates could result in 64% of those lakes becoming acidified. 107 refs., 16 figs., 7 tabs.

51732 (GKSS–89/E/54) **The settling velocity of suspended solid matter in the river Elbe at Lauenburg and Buntheus, August 1989.** Puls, W. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Kuehl, H. GKSS-Forschungszentrum Geesthacht GmbH, Hamburg (Germany, F.R.). 1989. 43p. (In German). Order Number DE91706218. Source: NTIS (US Sales Only), PC A03/MF A01.

In August 1989 the settling velocity and the concentration of suspended solid matter was measured in the Elbe river at Bunthaus and Lauenburg by using an Owen-tube. The fluvial discharge of the Elbe river in summer 1989 was less than 300 m^3/s which is an extremely low value. The aim of the measurements was to investigate the characteristics of suspended matter at this low fluvial discharge. The results show that the settling velocities were not extreme, but that the suspended matter concentrations were above avarage. In the storage lake near Geesthacht the suspended matter concentration at the water surface decreased from Lauenburg to the weir by about 75%. (orig.) With 18 figs.

51733 (GKSS–89/E/60) **Settling velocity measurements of mud flocs in the river Ems, comparison with measurements in the river Elbe.** Schulze, M. (Technische Univ. Braunschweig (Germany, F.R.). Leichtweiss-Institut fuer Wasserbau); Puls, W.; Kuehl, H. GKSS-Forschungszentrum Geesthacht GmbH, Hamburg (Germany, F.R.). 1989. 25p. (In German). Order Number DE91706217. Source: NTIS (US Sales Only), PC A03/MF A01.

In the region of brackish water in the Ems-estuary near the village of Gandersum, the settling velocity of mud flocs was measured during the tidal cycle. The settling velocity was found to be approximately proportional to the concentration of suspended matter. The data had no correlation between the settling velocity and the water salinity. The settling velocity of flocs in the Elbe-, Weser-, and Thames-estuary is essentially lower compared to the settling velocity of mud flocs in the Ems-estuary. (orig./HK) With 13 figs., 1 tab.

51734 (IWD/AR/WQB–89-152) **Major ion dynamics of surface waters of varying hydrologic order.** Howell, G. Inland Waters Directorate, Moncton, NB (Canada). Water Quality Branch. [1989]. 143p. (MICROLOG–90-03147). Source: PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The seasonal patterns of major ion chemistry for eight streams and two lakes situated in the vincinity of Kejimkujik National Park (Nova Scotia) are considered. Sulphate concentrations exhibit the same seasonal pattern in all the systems investigated with minima occurring during the summer and maxima occurring during the late winter, early spring. Comparison of atmospheric deposition with river export indicates that sulphate in these systems is predominantly from atmospheric supply as annual wet sulphate deposition can account for approximately 80% of the annual river sulphate export. However, there is strong seasonal cycling in these systems with sulphate being retained from May to November and lost from December to April. The dissolved organic carbon (DOC) seasonal patterns in these systems are highly variable. The low order streams have DOC maxima during the late summer and fall and minima during late spring. The much higher order river have DOC maxima during the winter and minima during late spring and early summer. Other terrestrially derived variables (calcium, magnesium and silica) exhibit similar seasonal patterns. The patterns of DOC and sulphate observed indicate that both mineral and organic acids are important in the acidification of these systems. In the low order streams mineral acids dominate during the spring while organic acids dominate during the summer. In the higher order systems

there is no clear cut seasonal dominance of either organic or mineral acids. However, major changes in pH in these systems tend to be associated with changes in sulphate concentrations rather than in DOC concentrations. 51 refs., 66 figs., 3 tabs.

51735 (KFK–4689) **Automated water analysis for the determination of calcium, magnesium, sulfate, carbonate, phosphate and ammonia by potentiometric titration techniques.** Hoefert, N. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Radiochemie; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Chemie. Apr 1990. 125p. (In German). Order Number DE91705961. Source: NTIS (US Sales Only), PC A06/MF A01.

An automated process was developed, which allows the determination of the concentrations of calcium, magnesium, sulfate, carbonate, phosphate and ammonia in aqueous solutions by potentiometric titration techniques. The apparatus consists of a titrator, which controls five automatic burettes (HCl, NaOH, Na_4EGTA, Na_4EDTA, $BaCl_2$/acetyl-acetone) and two magnetic valves. The titration data and additional data are read by a pH-electrode, a calcium-selective electrode in combination with a calomel reference-electrode, a conductivity cell and a resistance thermometer. A parallel interface connects the titrator to a computer, which processes the data by means of a BASIC-programme. The concentrations of carbonate, phosphate and ammonia are determined by acid-base titrations, in this case by end-point titrations to predetermined pH-values. It was shown that by this method it is possible in principle to determine the three constituents simultaneously. For reasons of precision it is advantageous to separate the titrations in such a way that the titration-points necessary for the determination of carbonate are firstly determined. Then the carbonate is removed as CO_2 by reducing the pH and bubbling argon through the solution. Secondly the titration-points necessary for the determination of phosphate and ammonia are taken by titration with NaOH. In presence of calcium and magnesium ions a complexing agent has to be added before the titration is carried out, in order to prevent the precipitation of calcium and magnesium salts at higher pH-values. EDTA and EGTA were used for this purpose. (orig.).

51736 (MUN/CCORE–90-04218) **Five year research plan, 1990-1994.** Memorial Univ. of Newfoundland, St. John's, NF (Canada). Centre for Cold Ocean Resources Engineering. [1989]. 20p. (MICROLOG–90-04218). Source: PC Centre for Cold Ocean Resources Engineering, C-CORE, Memorial University of Nfld., St. John's, NF, CAN A1B 3X5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Centre for Cold Ocean Resources Engineering is an independently funded research institute involved in solving engineering problems related to resource development in cold oceans. The Centre undertakes research ice engineering, remote sensing, and seabed geotechnics. This 5-year research plan describes activities in each of these 3 areas for the next 5 years and identifies new initiatives or changes of emphasis from the past plan. The centre has increased its emphasis on ice management, particularly in relation to the organization and handling of ice data and ice forecasting. In addition, environmental issues have been given increased importance, particularly those relating to the effect of global warming in northern waters, and oil spills in pack ice. Areas of new research in seabed geotechnics include environmental monitoring/assessment, bio-acoustics, artificial intelligence, geographical information processing and field applications of the Acoustic Sub-seabed Interrogator concept. Research in remote sensing will focus on ice and iceberg hazard detection systems which can be placed on structures and vessels. 3 figs.

51737 (OE–90-04766) **The acidification of Ontario lakes: An assessment of their sensitivity and current status with respect to biological damage.** Ontario Ministry of the Environment, Toronto, ON (Canada). Jan 1990. 188p. (MICROLOG–90-04766). Source: PC Ontario Ministry of the Environment, Public Information Centre, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report provides an update of the acid sensitivity data on lakes in Ontario, documents the analytical methods and data sources, and provides estimates for some areas of the province of the total number of lakes in various pH and alkalinity classes, which are interpreted in terms of the aquatic resources at risk in the province. It was concluded that atmoshperic deposition of sulphate is the major source of sulphate in Ontario lakes, and is strongly correlated with significant reduction of pH and acid neutralizing capacity in low-ionic strength lakes. There are at least 19,000 lakes in Ontario estimated to have been acidified to the point ($pH \leq 6.0$) where adverse biological effects have occurred. Also, the majority of the acidified lakes (over 11,000) are in central Ontario, where total annual sulphur deposition exceeds 0.75 gS $m^{-2}yr^{-1}$. This deposition region includes Haliburton, Muskoka, Parry Sound, Nipissing, Timiskaming, Sudbury and Algoma. A large number of the acidified (7,300) lakes are in the Sudbury area, and have been acidified primarily by past sulphur emissions from the Sudbury smelters. There are at least 7,250 lakes in Ontario estimated to be very acidic, with all of their acid neutralizing capacity eliminated ($alkalinity \leq 0$). In conclusion, acidification due to natural organic acids is not a major factor in explaining the acidification of lakes. 39 refs., 44 figs., 71 tabs.

51738 (OE/RT–90-03626-Vol.1, pp. 414-416, Paper BP4) **The origin and distribution of methane in the Alliston aquifer complex, southern Ontario.** Aravena, R. (Dept. of Earth Sciences Univ. of Waterloo, Waterloo, ON (Canada)); Wassenaar, L.; Barker, J.; Gillham, R. Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Methane is a major ground water contaminant in some parts of the Alliston aquifer complex. This paper attempts to establish the distribution pattern of methane and to provide a reasonable model for the origin and prediction of methane in the aquifier. The research approach includes the use of geological, hydrological and geochemical tools. An extensive groundwater sampling program that includes deep overburden and bedrock wells, representing most of the aquifer, has been carried out in order to evaluate the distribution of methane and geochemistry of groundwater in the aquifer. Results indicate that methane in the aquifer is formed by microbial processes and is not thermocatalytic. The nature of the Paleozoic bedrock does not control the distribution of methane in the aquifer. Methane and dissolved organic carbon appear to be linked to a common organic rich carbon source present in some parts of the aquifer. Some parts of the aquifer contain very old groundwater that was recharged under cooler conditions than at present or reflected the input of glacial meltwater.

51739 (OE/RT–90-03626-Vol.1, pp. 460-462, Paper BP19) **Carbon, sulfur, and nitrogen cycling in three unconfined aquifer systems in Ontario.** Wassenan, L.I. (Dept. of Earth Science, Univ. of Waterloo, Waterloo, ON (Canada)); Aravena, R.O.; Barker, J.F.; Gillham, R.W. Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This paper evaluates the origin, fluxes, and geochemistry of soluble organic matter in three shallow sand aquifers located near Rodney, Alliston and Sturgeon Falls, as well as the role of naturally

occurring soluble organic matter (DOC) in microbially mediated redox processes that affect the various carbon, nitrogen and sulfur pools. Based on $\delta^{34}S$ analyses of aqueous sulfate, it was concluded that sulfate at Sturgeon Falls and Alliston is derived from acid rain deposition, whereas at Rodney additional sulfate is derived from oxidation of organic bound and/or mineral sulfur. The nitrate at Rodney and Alliston is derived from fertilizers and agricultural practices. Bacterial remediation occurs at Rodney and Sturgeon Falls, but not at Alliston. Data show that high molecular weight (HMW) soluble organic matter at Rodney is rapidly flushed to the groundwater during recharge from the upper few centimeters of the soil profile in less than 2 years. The HMW DOC is composed of a mixture of old and young carbon, having a mean residence time of 600 years. Low molecular weight DOC has ages similar to the aquifer kerogen, suggesting a link between the aqueous and solid organic carbon pools. In the Sturgeon Falls aquifer HMW DOC entering the groundwater indicates soluble organic matter has residence times less than 30 years, and is recharged to the system in less than 1-2 years. Data also indicate labile organic carbon may also be produced by fermenting bacteria acting on kerogen indigenous to the aquifer material. At the Alliston site, a long residence time for soluble organic matter in the vadose zone is postulated due to a thick unsaturated zone, resulting in refractory, nonlabile DOC reaching the groundwater.

51740 (OE/RT–90-03626-Vol.1, pp. 417-419, Paper BP5) **Microbial methylation of mercury in acid stressed lakes: Role of sulphate reducing bacteria.** Kerry, A. (BIOS Environmental Research, Toronto, ON (Canada)); Stokes, P.M.; Prucha, B.; Mierle, G. Ontario Ministry of the Environment, Toronto, ON (Canada). Research and Technology Branch. 1989. (CONF-8911230–: Environmental research: technology transfer conference, Toronto (Canada), 20-21 Nov 1989; MICROLOG–90-03626). In *Proceedings [of the] Environmental research: Technology transfer conference: Volume 1. Feature presentations, air quality research, water quality research.* 486p. Source: PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Methylation of mercury by microorganisms produces a form of mercury that is more toxic and more biologically available to biota than is inorganic mercury. Microbial communities in lake sediment are known to methylate inorganic mercury and logically, factors which change or stimulate portions of this community can influence the rate of methylation. The increased input of sulphate from acidic deposition may stimulate sulphate-reducing bacteria over the other sediment populations thereby potentially increasing the rate of methylmercury production in the system. The role of freshwater sulphate-reducing bacteria from the Muskoka-Haliburton area (Dickie Lake, pH 5.7) in methylmercury production was examined by adding specific microbial inhibitors to anoxic lake sediments spiked with $^{209}HgCl_2$. The effect of increased sulphate activity of sulphate-reducing bacteria both in terms of sulphate reduction rate and methylation of mercury was examined by adding appropriate ranges of concentrations of sulphate to $^{209}HgCl_2$ spiked sediment. It was found that sulphate-reducing bacteria do appear to be major methylators of mercury in freshwater, anoxic sediments and were more important in this respect than methanogens. However, the stimulatory effect of sulphate, within normal levels, on these bacteria's ability to further methylate mercury remains unclear. 20 refs., 2 figs.

51741 (OH/RD–89-276-K) **Atikokan TGS [thermal generating station] aquatic studies, 1981 to 1988.: 2. Water chemistry.** Haymes, G.T. Ontario Hydro, Toronto, ON (Canada). Research Div. 24 Nov 1989. 45p. (MICROLOG–90-03529). Source: PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, ON, CAN K1A 0G1.

Comparison of chemical data collected prior to and during the operation of the Atikokan Thermal Generating Station indicated that changes in many chemical parameters were a reflection of the relocation of water through the station from Moose and Marmion Lakes into Snow, Icy and Abie Lakes. This trend was most apparent for conservative parameters such as alkalinity, calcium, chloride, dissolved solids and hardness but for more dynamic parameters such as total phosphorus the trend was only apparent when the station was consistently operating. pH levels increased after 1981, but this appeared to be a general phenomenon unrelated to station operation or construction. Most hypothesized effects of station operation on water chemistry were considered incorrect due to the substantial influence of water relocation on the chemistry of the lakes. With the exception of iron, the the frequency of exceedances of provincial water quality objectives did not increase during operation of the station. 16 refs., 11 figs., 9 tabs.

51742 (ORNL/FTR–3747) **[International meetings on ecology]: Foreign trip report, August 16, 1990–September 4, 1990.** DeAngelis, D.L.; Garten, C.T. Jr.; Turner, M.G. Oak Ridge National Lab., TN (USA). 25 Sep 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000700. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

the travelers attended the Fifth International Congress of Ecology (INTECOL) in Yokohama, Japan, and two presented invited papers and chaired symposia. One traveler also attended the OJI International Seminar in Gifu, Japan and the Fukuoka Symposium on Theoretical Ecology in Fukuoka, Japan and presented invited papers. At these scientific gatherings, a large number of symposia and specific presentations were relevant to current research at Oak Ridge National Laboratory (ORNL), especially in the areas of landscape dynamics, plant physiology, and aquatic ecosystems.

51743 (PB–90-252594/XAB) **Emerging technologies: Bio-Recovery Systems removal and recovery of metal ions from ground water.** Darnall, D.W.; Hosea, J.M. Bio-Recovery Systems, Inc., Las Cruces, NM (USA). Aug 1990. 55p. Source: NTIS, PC A04/MF A01.

See also Appendices, PB–90-252602.

A series of laboratory tests and an on-site pilot scale demonstration of Bio-Recovery Systems' AlgaSORB technology for the removal and recovery of mercury-contaminated groundwater were conducted under the SITE program. Optimum conditions were determined for mercury binding to AlgaSORB. Conditions under which mercury could be stripped from AlgaSORB were developed. On-site, pilot scale demonstrations with a portable waste treatment system incorporating columns containing two different AlgaSORB preparations confirmed laboratory tests. Over 500 bed volumes of mercury-contaminated groundwater could be successfully treated before regeneration of the system was required. Mercury was removed to levels below the discharge limit of 10 microgram/L.

51744 (PB–90-252602/XAB) **Emerging technologies: Bio-Recovery Systems removal and recovery of metal ions from ground water. Appendices.** Darnall, D.W.; Hosea, J.M. Bio-Recovery Systems, Inc., Las Cruces, NM (USA). Aug 1990. 118p. Source: NTIS, PC A06/MF A01.

See also PB–90-252594.

Now in its fourth year, the Superfund Innovative Technology Evaluation (SITE) Program is part of EPA's research into cleanup methods for hazardous waste sites around the nation. Through cooperative agreements with developers, alternative or innovative technologies are refined at the bench-and pilot-scale level and then demonstrated at actual sites. EPA collects and evaluates extensive performance data on each technology to use in remediation decision-making for hazardous waste sites. The appendices include the laboratory analysis results from two independent laboratories that were provided split samples from two Bio-Recovery Systems, Inc. during the on-site pilot testing of Bio-Recovery's technology f or the removal of mercury from contaminated groundwaters during the period of November 7, 1989 to December 1, 1989.

51745 (PB–90-253626/XAB) **Health assessment for Jones Industrial Services Landfill, South Brunswick Township, Middlesex County, New Jersey, Region 2. CERCLIS No. NJD097400998. Final report.** New Jersey State Dept. of Health, Trenton, NJ (USA). 30 Jul 1990. 15p. Source: NTIS, PC A03/MF A01.

See also PB–90-139130.

The Jones Industrial Landfill site began as a 33-acre pit that had been excavated to provide soil needed during the construction of the New Jersey Turnpike. Landfilling operations reportedly began in 1955. In the 1960's, as part of the landfilling operation, toxic chemicals were dumped into the pit. The site is currently ranked 45 of 110 Superfund sites in New Jersey. The primary pathway of concern is the domestic use of contaminated groundwater. Residents near the JIS landfill have experienced contamination of their well water since 1975. On-site contamination of groundwater and soil has occurred predominantly by volatile organic compounds (VOCs), pesticides and heavy metals. On the basis of the information reviewed, ATSDR and NJDOH have concluded that the site is of public health concern because humans have probably been exposed to VOCs, heavy metals, phthalates and pesticides at concentrations that may result in adverse health effects. The Jones Industrial Services Landfill site is being considered for appropriate follow-up health study and evaluation.

51746 (PB–90-256140/XAB) **Health assessment for Savage Municipal Well, Milford, Hillsborough County, New Hampshire, Region 1. CERCLIS No. NHD980671002 (amended). Preliminary report (Final).** New Hampshire Dept. of Health and Human Services, Concord, NH (USA). Environmental Health Risk Assessment Unit. 4 Apr 1990. 10p. Source: NTIS, PC A02/MF A01.

See also PB–90-137811.

The Savage Municipal Well Site is listed on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL). The site consists of four industries within a half mile of the Savage Municipal Well. These industries have contributed to the contamination of groundwater, surface water and soils with volatile organic compounds (VOCs). The four industries identified as potentially responsible parties are Hendrix Wire and Cable Company, Inc., Hitchiner Manufacturing, Inc., New England Steel Fabricators, Inc., and O.K. Tool Company, Inc. (defunct). The site lies immediately south of the Souhegan River. Three hydrogeological investigations of contaminated areas have been conducted to date, including the hydrogeological study conducted by the NH WSPCC. The other two studies were separate company-initiated investigations of O.K. Tool and Hitchiner Manufacturing properties. Data from these studies were incorporated in the NH WSPCC report. Based on the available information, the Savage Well Site is considered to be of public health concern because of the risk to public health caused by prior exposure and potential future exposure to hazardous substances via the consumption of contaminated groundwater; direct contact with contaminated soils, surface water, and sediment; inhalation of contaminated soil and air; and incidental ingestion of contaminated soil, surface water, and sediment.

51747 (PB–90-256413/XAB) **Guides to pollution prevention: The printed-circuit-board manufacturing industry.** Jacobs Engineering Group, Inc., Pasadena, CA (USA). Jun 1990. 84p. Contract EPA-68-02-4286. Source: NTIS, PC A05/MF A01.

The guide identifies and analyzes waste minimization methodologies appropriate for the printed circuit board manufacturing industry. The wastes resulting from printed circuit board manufacturing are associated with five types of processes: cleaning and surface preparation; catalyst application and electroless plating; pattern printing and masking; electroplating; and etching. The wastes themselves include airborne particulates, spent acids and alkaline solutions, spent solvents, spent plating baths, waste rinsewater, and other wastes. The guide also presents a set of detailed waste minimization assessment worksheets suitable for use by shop managers and engineers, or by outside consultants, to formulate a waste minimization strategy for the particular plant. Finally, case histories of waste minimization assessments performed at three plants are given.

51748 (PB–90-256421/XAB) **Guides to pollution prevention: Selected hospital waste streams.** Jacobs Engineering Group, Inc., Pasadena, CA (USA). Jun 1990. 52p. Contract EPA-68-02-4286. Source: NTIS, PC A04/MF A01.

The hazardous wastes generated by general medical and surgical hospitals are small in volume relative to those of industrial facilities; however, the wastes are of a wide variety. Some of the hazardous materials used by hospitals that become part of their waste streams include chemotherapy and antineoplastic chemicals, solvents, formaldehyde, photographic chemicals, radionuclides, mercury, waste anesthetic gases; and other toxic, corrosive and miscellaneous chemicals. Additional wastes such as infectious waste, incinerator exhaust, laundry-related waste, utility wastes, and trash were not addressed in the guide. Reducing the generation of these materials at the source, or recycling the wastes on- or off-site, will benefit hospitals by reducing disposal costs and lowering the liabilities associated with hazardous waste disposal. The guide provides an overview of hospital waste generating processes and presents options for minimizing waste generation through source reduction and recycling.

51749 (PB–90-256579/XAB) **Radionuclide concentrations from waters of selected aquifers in Georgia. Technical report.** Coker, G.; Olive, R. Georgia Univ., Athens, GA (USA). Inst. of Ecology. 1989. 29p. Source: NTIS, PC A03/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the US Environmental Protection Agency. In 1988 the US Environmental Protection Agency, Region IV, began a pilot study to investigate the natural occurrence and concentration of Uranium 238, Thorium 232, and Uranium 235 radionuclide series in the ground water for selected aquifers in Georgia. Specific rock types, somewhat geologically homogeneous, were selected as representative of one or more aquifers for each of the geologic provinces in Georgia (Piedmont, Blue Ridge, Valley & Ridge, and Coastal Plain). Aquifers sampled within the Piedmont provinces included pre-Cambrian and Paleozoic granite/gneisses and granites from four Piedmont county areas (Gwinnett/Barrow, Greene, Elbert/Oglethorpe, and Spalding/Pike). Ground waters from private water supply wells developed in these aquifers were sampled and analyzed for their radioisotopic and chemical characteristics. Preliminary analysis of 90 ground-water and radioisotopic samples from the pilot study indicates that the geologic setting of the differing aquifers an provinces strongly influences the occurrence of natural radioisotopes in drinking water. Extremely high concentrations of uranium, radium, radon 222, lead 210, and polonium 210 in some aquifers indicate radioisotope enrichment within and near the well bore for some areas. Based on these findings, the present public water monitoring scheme, which is based on gross alpha particle activity, may require modification depending on differing isotopes, rock types, and geological provinces.

51750 (PB–90-256587/XAB) **Geographic information System technology applications to Ground-Water Management Program, EPA Region 3. Technical report.** Clibanoff, A. Drexel Univ., Philadelphia, PA (USA). Dept. of Civil Engineering. 1989. 21p. Source: NTIS, PC A03/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. GIS technology is a computer informational system that stores, analyzes, and manipulates both spatial and non-spatial data. Base map information for the GIS has come primarily from the USGS. Data for the entire Region at the 1:2,000,000 scale and for some of the Region at the 1:100,000 scale is currently being used. Data from GIRAS, a land use Database, at the 1:250,000 also exists for much of the Region. Information is contributed to the GIS from various sources including but not limited to RCRA, CERCLA, UIC, and UST programs. The WHP program is also being tapped to identify locations of public water supply wells. Region III is interested in any data that accurately describes the ground water condition in a given area. In Regional pilot studies being conducted, GIS is being employed at both the regional and county level. The goals of the pilot studies include the identification of areas of ground water susceptibility and major sources of ground water contamination, and prioritizing the Region's ground water supplies in terms of vulnerability to pollution and risk to the population.

51751 (PB–90-256645/XAB) **Proposal for sampling methods data base: A Hypertext approach to hazardous-waste cleanup. Technical report.** Peterson, D. Brigham Young Univ., Provo, UT (USA). 1989. 15p. Source: NTIS, PC A03/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental

Protection Agency. The intent of developing a computerized database is that it will facilitate inquiries into hazardous waste cleanup – what equipment to use in the field, and which sampling and analytical methods would be proper given certain environmental conditions. The NNEMS project serves as a proposal on how further research should be conducted on the sampling issue and which computer software package would be best suited for that purpose. Currently, EPA databases lack sufficient information or the information is too scattered for an individual to find complete answers on questions relating to hazardous waste cleanup. The project defines suitable information to incorporate in a new database. It will include such information as: standards, sampling methods, quality assurance materials, and analytical methods. The proposed project will be written in KnowledgePro, a program which uses hypertext combined with database capabilities. It is easy to use and simple to program and reads EPA owned ASCII text files, Lotus and dBASE III files. This will enable EPA employees to access pertinent information related to hazardous waste cleanup.

51752 (PB–90-256744/XAB) **Report on land-based sources of marine pollution in the Caribbean. Technical report.** Betz, K.E. Michigan Univ., Ann Arbor, MI (USA). 1989. 175p. Source: NTIS, PC A08/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The document presents information gathered during a series of interviews with professionals from governmental agencies in each of the Caribbean nations, with the exception of the U.S. possessions. The report provides, on a nation-by-nation basis, background information regarding the sources of pollution and the agencies within each nation which retain some authority to remedy or otherwise manage these problems. Names of contact persons within these agencies, their phone numbers and addresses are also provided. The audience for the report is persons within organizations in the Caribbean Basin nations working to coordinate activities aimed at identifying and reducing land based sources of marine pollution. The report is a resource for achieving unified environmental efforts in the region. The final section briefly notes factors which may work in favor of regional solutions and those that may not.

51753 (PB–90-258963/XAB) **Laboratory and pilot-scale evaluations of physical/chemical treatment technologies for MGP site groundwaters. Topical report, January 1989-May 1990.** Weightman, R.L.; Smith, J.R. Remediation Technologies, Inc., Pittsburgh, PA (USA). May 1990. 230p. Contract GRI-5086-254-1334. Source: NTIS, PC A11/MF A02.

Treatability studies were performed to evaluate the treatment of Manufactured Gas Plant (MGP) site groundwaters using the following treatment processes: gravity separation, coagulation/flocculation, sand filtration, air stripping, carbon adsorption, and chemical oxidation. Treatment results for conventional parameters, inorganic compounds, metals, volatile aromatics, phenolics, and polynuclear aromatic hydrocarbons are presented and compared to regulatory limits associated with discharge to a Publicly Owned Treatment Works (POTW), discharge to a surface water body, or subsurface injection. Equipment costs as well as operating and maintenance costs are presented for several treatment strategies designed to achieve compliance with alternative discharge requirements.

51754 (PB–90-260076/XAB) **Health assessment for Potter's Septic Tank Service Pits, Maco, Brunswick County, North Carolina, Region 4. CERCLIS No. NCD981023260. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Jul 1990. 19p. Source: NTIS, PC A03/MF A01.

The Potter's Septic Tank Service Pits site–located in Maco, North Carolina–has been placed on the National Priorities List by the U.S. Environmental Protection Agency. The site was used to dispose of waste oil, creosote, and septic sludge, either in shallow, unlined pits or by surface application. An EPA emergency removal occurred at the site in 1983. Soil-gas levels in Area 3 did not show contamination, and unless soil samples show otherwise, the site definition of Potter's Septic Tank Service Pits will include only the area known as Area 1. Volatile organic hydrocarbons, heavy metals, and polynuclear aromatic hydrocarbons found in shallow groundwater samples suggest that a large reservoir of contamination may remain at Area 1. The efficiency of the 1983 soil removal was not documented. Based upon information reviewed, the Agency for Toxic Substances and Disease Registry (ATSDR) has concluded that the site is of potential public health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Human exposure to volatile organic hydrocarbons, heavy metals, and polynuclear aromatic hydrocarbons may occur and may have occurred in the past via groundwater, surface water, soil, sediment, air, and the food chain. Recommendations are provided concerning a well monitoring program for residences in the area of the site.

51755 (PB–90-260092/XAB) **Health assessment for Richardson Flat Tailings, Park City, Summit County, Utah, Region 8. CERCLIS No. UTD980952840. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 24 Jul 1990. 21p. Source: NTIS, PC A03/MF A01.

The Richardson Flat Tailings, an Update 7 site proposed for the National Priorities List, is located 3.5 miles northeast of Park City, Summit County, Utah. From 1975 to 1981, the 160-acre site was used for disposing mine tailing wastes from the Keetly Ontario Mine and other mines owned by United Park City Mines. Currently no tailings are dumped at the site; however, soil from the site is being excavated and used to cover the tailings piles. Several metal contaminants, including arsenic, cadmium, chromium, lead, and zinc, have been detected in on-site and off-site areas. Contaminants may migrate from the site to off-site areas through surface water, groundwater, and airborne-associated pathways. Human exposure to site contaminants may occur through the ingestion of contaminated groundwater, food-chain entities, and soil; through dermal contact with contaminants; and through the inhalation of airborne dusts. The site is considered to be of potential public health concern because of the high levels of on-site contaminants.

51756 (PB–90-260100/XAB) **Health assessment for Redwing Carriers, Inc. (Saraland), Saraland, Alabama, Region 4. CERCLIS No. ALD980844385. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 18 Jul 1990. 21p. Source: NTIS, PC A03/MF A01.

The Redwing Carriers, Inc. (Saraland) site is in the community of Saraland, in Mobile County, Alabama. The site, about 1 acre, is in an urbanized area and had been used as a truck terminal between 1961 and 1971. Redwing Carriers cleaned out trucks that transported a variety of materials, including asphalt, diesel fuel, herbicides, tall oil, and sulfuric acid. Wastes were discharged onto the ground. The property was covered with fill material, and an apartment complex, housing about 180 tenants, was developed. On-site monitoring identified polynuclear aromatic hydrocarbons and a few other organic compounds in surface wastes and in subsurface wastes and soils. Using the information reviewed, the Agency for Toxic Substances and Disease Registry concludes that the site is of potential public health concern because humans may be exposed to hazardous substances at concentrations that may result in adverse health effects. Children are the most likely to be exposed to the contaminants associated with the recurring surficial waste deposits. Available monitoring data are not sufficient to clarify whether groundwater, ambient air, air in buildings, soils, sediments, surface water, and food-chain entities contain contaminants at levels that pose public health concerns or physical hazards.

51757 (PB–90-260126/XAB) **Health assessment for Maywood Chemical Company, Maywood, Bergen County, New Jersey, Region 2. CERCLIS No. NJD980529762. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 30 Jul 1990. 24p. Source: NTIS, PC A03/MF A01.

The Health Assessment for the Maywood Chemical Company Site includes the Maywood Interim Storage Site (MISS), the Ballod property, the Scanel site, residential properties, and the Sears warehouse and its adjacent properties, all of which are located in the towns of Maywood and Rochelle Park of Bergen County, New Jersey. These sites are at different investigative or remediation

stages under the auspices of both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE). The EPA is responsible for chemical characterization and cleanup operations, whereas the DOE is primarily in charge of radiologic analysis and remediation. On the basis of the information reviewed, ATSDR and NJDOH have concluded that the Maywood Chemical site is of public health concern because humans have probably been exposed to hazardous substances at concentrations that may result in adverse health effects. As noted in the Environmental Contamination and Physical Hazards section above, human exposure to chemical and radiological contamination is probably occurring and has probably occurred in the past via the use of contaminated groundwater and contact with contaminated soils. Before suspected areas of contamination are developed, both on-site contamination and the potential off-site migration of contaminants need to be fully evaluated. Developing an area, without characterizing potential contamination could lead to an adverse impact on the public health.

51758 (PNL-SA–18038) **A synoptic summary approach to better understanding groundwater contamination problems and evaluating long-term environmental consequences.** Nelson, R.W. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 19p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830 ;AC04-76DP00789. (CONF-900484–3: 26. annual meeting of the National Council on Radiation Protection and Measurements, Washington, DC (USA), 4-5 Apr 1990). Order Number DE91000416. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A summary approach has been developed within groundwater hydrology to communicate with a broad audience and more completely evaluate the long-term impacts of subsurface contamination problems. This synoptic approach both highlights the dominant features occurring in subsurface contamination problems and emphasizes the information required to determine the long-term environmental impacts. The special merit of a summary approach is in providing a better understanding of subsurface contamination problems to adjoining technical disciplines, public decision makers, and private citizens. 14 refs.

51759 **American Chemical Society, Division of Environmental Chemistry, Vol. 30, No. 1.** 598p. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Separate abstracts were prepared for 86 papers presented at this divisional meeting of the 199th ACS National Meeting.

51760 **Normal and surface-enhanced Raman scattering with optical fibers.** Myrick, M.L. (Environmental Sciences Div., Lawrence Livermore National Lab,. CA (US)); Angel, S.M. pp. 38-48 of Chemical, biochemical, and environmental fiber sensors: Volume 1172. Lieberman, R.A.; Wlodarczyk, M.T. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 318 (CONF-8909177–: O/E Fibers '89: meeting of the International Society for Optical Engineering, Boston, MA (USA), 5-8 Sep 1989).

Raman scattering techniques, because of the vibrational information they contain, have numerous applications in the measurement and identification of aqueous pollutants in groundwater as well as other contaminated waters. However, the extension of Raman techniques using fiber optics to remote sensing of ground water is not completely straightforward. Single-fiber optrodes provide the greatest signals but also large background levels. Multiple-fiber optrodes offer lower background levels but are not practical over very long distances and are not as sensitive as single-fiber optrodes. The difficulties of obtaining Raman spectra with fiber optics are discussed, and the potential techniques for overcoming the limitations of single-fiber devices are described. The results of Raman spectral measurement that were made using a dual-fiber optrode in a novel forward-scattering configuration are presented. The possible extension of these results to surface-enhanced Raman (SER) scattering is discussed. In addition initial results of SERS performed with optical fibers are presented, along with a description of future directions for this research.

51761 **Epilithic microbial populations and leaf decomposition in acid-stressed streams.** Palumbo, A.V. (Environmental Sciences Division, Oak Ridge National Lab., Oak Ridge, TN (US)); Mulholland, P.J.; Elwood, J.W. pp. 69-90 of Acid stress and aquatic microbial interactions. Rao, S.S. CRC Press Inc., Boca Raton, FL (USA) (1989). pp. 174

The number of bacteria on decomposing leaf material (direct counts of acridine orange-stained bacteria) and bacterial production on leaf material and on rock surfaces (incorporation of tritiated thymidine into deoxyribonucleic acid, DNA) were measured as part of a study of the effects of acidification on microbial communities in streams. The number of bacteria on leaf material ranged from 3.3 $\times 10^{10}$ to 12.4 $\times 10^{10}$ cells per gram dry weight, it was not significantly different among streams of different pH and aluminum concentration, it increased over the 1st 4 weeks of incubation, and it was relatively constant thereafter at all sites. There was no significant dilution of added thymidine by unlabeled internal or external pools of thymidine in measurements of bacterial production on leaf material. Bacterial production on both leaf and rock surfaces was significantly greater in streams with higher pH (> 5.5) than at matched sites in nearby streams with low pH (< 5.0). However, differences in productivity among sites were not evident until after 2 weeks of incubation of leaf material in the streams, and significant differences could not be generated in short-term (< 48-H) transplants of rock material from high to low pH sites. Therefore, the effects of acidification on bacteria do not appear to be due to acute toxicity.

51762 **Drilling and sampling procedures to minimize borehole cross-contamination.** Russell, B.F. (Idaho National Engineering Lab., Idaho Falls (USA)); Hubbell, J.M.; Minkin, S.C. pp. 81-93 of The proceedings of the third national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods. National Water Well Association, Dublin, OH (US) (1989). pp. 1161 DOE Contract AC07-76ID01570. (CONF-8905127–: 3. National Water Well Association outdoor action conference, Orlando, FL (USA), 22-25 May 1989).

Drilling and sampling procedures have been developed by scientists from the Idaho National Engineering Laboratory (INEL) to minimize the potential of cross-contamination within the borehole or from airborne contaminants. These procedures employ off-the-shelf wireline drilling equipment, including a Lexan inner core barrel. The procedures have been used in both air and mud rotary operations. Downhole quality assurance steps include the introduction of samarium oxide and/or perfluorocarbon tracers. The procedures were initially developed to support subsurface investigation at a low-level radioactive waste management complex in Idaho and have since been modified and used for Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) investigations in California and Idaho. Most recently, the procedures were employed in a research investigation in South Carolina to collect microorganisms from the deep subsurface. The procedures can be modified to reflect specific drilling objectives. Overall, the procedures have been effective in the minimization or elimination of cross-contamination. This approach to sampling represents the latest technology in hazardous waste subsurface investigations.

51763 **Delineation of brine drilling-fluid loss in an unsaturated zone - Application to contamination monitoring.** Bartel, L.C. (Sandia National Labs., Albuquerque, NM (USA)). pp. 841-854 of The proceedings of the third national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods. National Water Well Association, Dublin, OH (US) (1989). pp. 1161 DOE Contract AC04-76DP00789. (CONF-8905127–: 3. National Water Well Association outdoor action conference, Orlando, FL (USA), 22-25 May 1989).

The controlled-source audio frequency magnetotelluric (CSAMT) surface electromagnetic geophysical technique shows promise for delineation of zones of drilling-fluid loss and for delineating and monitoring zones of ground-water contamination in general. At the Waste Isolation Pilot Plant (WIPP) site near Carlsbad, NM, hydrology test wells are drilled with a brine drilling fluid where significant drilling-fluid losses often occur during drilling. Pre- and post-drilling CSAMT surveys were performed at the site of a newly drilled well.

During the drilling of this new hydrology test well, the majority of some 400 obls of brine drilling fluid were lost in an unsaturated zone at a depth of approximately 60 m. The pre- and post-drilling CSAMT survey measured apparent resistivities show marked decreases of over 30% for data stations near the newly drilled well, while at some distant data stations the changes were minimal. From an analysis of the data, the zone of lost drilling fluid was delineated. The results of these surveys show the application of the CSAMT surface geophysical technique, as well as electromagnetic surface geophysical techniques in general, to delineating and monitoring zones of ground-water contamination.

51764 Chemical sensing of chlorinated hydrocarbons by photo-SERS. Carrabba, M.M. (EIC Labs., Inc., Norwood, MA (USA)); Edmonds, R.; Rauh, R.D. pp. 983-984 of Electrochemical Society 1989 Fall meeting (Abstracts): Volume 89-2. The Electrochemical Society, Pennington, NJ (USA) (1990). pp. 1010 (CONF-8910107–: Electrochemical Society fall meeting, Hollywood, FL (USA), 15-20 Oct 1989).

Techniques to sense and monitor chlorinated hydrocarbon solvents (CHS) are becoming increasingly more important with their intensifying presence as groundwater pollutants. Previous work has shown the usefulness of surface enhanced Raman spectroscopy (SERS) for the detection of groundwater contaminants, and the techniques has recently been adapted to remote fiber optic sampling. However, these past experiments have mainly been restricted to aromatic hydrocarbons. The authors report on SERS of the following chlorinated hydrocarbons or organochlorides: carbon tetrachloride, 1,2-dichloroethane (DCE), chloroform and trichlorethylene (TCE).

51765 Optical spectroscopic screening of environmental water samples. Haas, J.W. III (Oak Ridge National Laboratory, TN (USA)); Gammage, R.B. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 109 (1990). DOE Contract AC05-84OR21400. (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

The monumental task of monitoring watersheds for anthropogenic organic chemical contamination can be facilitated by screening techniques which are rapid and inexpensive. One approach to screening is to use less sophisticated instruments and methods adapted for field use. The result is a much faster, if sometimes less detailed, assessment of a watershed than is obtained by conventional laboratory analysis. A second approach is to use instruments which make measurements in situ, thereby eliminating the time and expense of sample collection and handling. Using UV-visible and fluorescence spectroscopies, examples of both approaches will be presented for contaminated groundwater.

51766 Ultrasensitive fluorescence analysis in levitated microdroplets. Ramsey, J.M. (Oak Ridge National Laboratory, TN (USA)); Whitten, W.B. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 146 (1990). DOE Contract AC05-84OR21400. (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

The extreme sensitivity of fluorescence spectrophotometry results from the fact that a molecule can undergo many excitation-emission cycles before destruction by photochemical degradation. Sufficient signal exists for single molecules to be detectable. Detection limits for molecules in solution have been limited to $\approx 10^{-13}$ M by background signal from solvent Raman scattering and fluorescence. Fewer numbers of molecules are detectable by reduction of analysis volume. In our experiments the measurement volume, and hence the background signal, is reduced by observing a single microdroplet of solution levitated in an electrodynamic trap. An argon-ion laser is used to excite fluorescence from R6G molecules contained in glycerol droplets. We estimate our current detection limit at ≈100 R6G R6G molecules in 20-μm diameter glycerol droplets.

51767 PAH [polynuclear aromatic hydrocarbons] binding to natural organic matter (NOM): A comparison of NOM fractions and analytical methods. Amy, G.L. (Univ. of Arizona, Tucson (USA)); Liu, Houmao. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 243-246 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

It is well known that polynuclear aromatic hydrocarbons (PAHs) bind to humic substances. In this study, the binding of phenanthrene to natural organic matter (NOM) has been investigated by three methods: fluorescence quenching, reverse-phase separation using Sep-Pak (C-18), and dialysis. Two different sources of bulk NOM as well as various NOM fractions (e.g., molecular weight; humic versus non-humic) have been studied.

51768 Use of ^{14}C-labeled seston to study fine particulate organic matter dynamics in flowing water. Cushing, C.E. (Battelle-Pacific Northwest Laboratory, Richland, WA (USA)); Minshall, G.W.; Newbold, J.D. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 305-307 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Transport, deposition, and resuspension of fine particulate organic matter (FPOM, <1 mm) is an important aspect of the energy dynamics in streams. However, it has been virtually impossible to study these factors because of the difficulty in working with particles of such small sizes. Two papers (Banks and Wolfinbarger 1981 and Wolfinbarger and Crosby 1983) describing methods for labeling marine detritus with ^{14}C led us to explore these methods for studying FPOM dynamics in flowing water.

51769 Site specific interactions of two hydrophobic ionizable compounds on clay-coated-alumina. Szecsody, J.E. (Pacific Northwest Laboratory, Richland, WA (USA)); McBride, J.F. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 347-349 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

In groundwater systems containing soils with low organic content, sorption of hydrophobic ionizable compounds (HOC) can be attributed to interactions with 2:1 clay surfaces. The purpose of this research is to examine different sorption mechanisms on 2:1 clay surfaces in column systems and evaluate how sorption parameters might differ from batch sorption with clay sorbents. Two solutes, quinoline and 1-aminonaphthalene, are used in this research, where quinoline sorbs to montmorillonite by an ion exchange mechanism, whereas 1-aminonaphthalene is reported to undergo reversible sorption by ion exchange and an irreversible transformation on montmorillonite.

51770 Influence of mineral bound humic acids on the sorption of hydrophobic organic compounds. Murphy, E.M. (Battelle Pacific Northwest Laboratory, Richland, WA (USA)); Zachara, J.M.; Smith, S.C. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 350-352 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Dissolved humic substances are present in many ground waters (Thurman, 1985) and have been shown to bind or associate with hydrophobic organic compounds (HOC) facilitating HOC transport. Dissolved humic substances may also absorb to mineral surfaces, rendering hydrophilic surfaces hydrophobic and making them sorbents for HOC. The objectives of this work were to (1) investigate the dependence of HOC sorptivity on the fractional surface coverage of mineral surfaces with humic substances, (2) to establish whether HOC sorptivity was influenced by the aromaticity/aliphilicity of the humic coating, and (3) to identify whether different mineral surfaces imparted a different structure to the adsorbed organic substances that affected HOC sorption.

51771 The effects of groundwater chemistry on cometabolism of chlorinated solvents by methanotrophic bacteria. Palumbo, A.V. (Oak Ridge National Laboratory, TN (USA)); Strandberg, G.W.; Eng, W. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 30(1): 460-463 (1990). (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Degradation of chlorinated alkenes such as trichloroethylene (TCE) by methanotrophic bacteria is a promising technology for the

remediation of contaminated groundwater. Ultimately, the cost and the success of this approach may be dependent on the influence of groundwater chemistry on degradation rates and extent. TCE can rapidly be reduced to low levels in laboratory cultures growing on defined media. The goal of our research is to quantify the potential effects of groundwater chemistry on the biodegradation of TCE by methanotrophs and to define concentrations of methane that need to be added to the system. This includes work on major nutritional requirements (e.g. PO_4) but has focused on competitive inhibition and cofactors.

51772 Binding and bioavailability of organic micropollutants in natural waters: Effects of the quality and quantity of dissolved organic material. Kukkonen, J. (Univ. of Joensuu (Finland)); Oikari, Aimo; McCarthy, J.F. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA)*, 30(1): 513-516 (1990). DOE Contract AC05-84OR21400. (CONF-900402–: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

Humic substances or, more generally, dissolved organic material (DOM), in the natural waters are important in water chemistry and aquatic toxicology because number of studies have demonstrated that they can bind hydrophobic organic pollutants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and polychlorinated dioxins and dibenzofurans (1-3). However the affinity of the organic matter for binding a given pollutant varies among waters from different sources. The purpose of this study was to demonstrate that isolated subcomponents of DOM (XAD-8 fractionations) differ in their affinity for binding contaminants, and to determine whether the relative binding affinities and relative abundance of the subcomponents could account for the correlations observed in the different sources of DOM.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

Refer also to citation(s) 50990

5501 Behavioral Biology

Refer also to citation(s) 50701, 50702, 50703, 50704, 51695

5502 Biochemistry

Refer also to citation(s) 51366, 51367, 51368, 51369, 51370, 51786, 51787, 51799, 51801, 51839

51773 (CONF-9006194–2) **The structure and function of membrane protein photosynthetic reaction center.** Chang, Chong-Hwan; Tiede, D.; Norris, J.; Schiffer, M. Argonne National Lab., IL (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services. DOE Contract W-31109-ENG-38. Grant GM36598. From 11. international science and technology symposium; Seoul (Republic of Korea); 25-29 Jun 1990. Order Number DE90017795. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The three dimensional structure of the photosynthetic reaction center from Rhodobacter (Rb.) sphaeroides has been determined using x-ray diffraction technique. It has 11 membrane spanning helixes, five each from the L and M subunit and one from the H subunit. There is a pseudo-twofold symmetry between the L and M subunits and their amino acid sequences have some similarity. The pigment components, which are located at the hydrophobic core of the reaction center also have this symmetry. We confirmed that two bacteriochlorophylls have a predicted conformation called a "special pair." The nonheme iron is liganded with four histidines and one glutamic acid. 13 refs., 2 figs.

51774 (CONF-9008116–1) **Drug delivery by organ-specific immunoliposomes.** Maruyama, Kazuo (Tennessee Univ., Knoxville, TN (USA). Dept. of Biochemistry); Mori, Atsuhide; Hunag, Leaf; Kennel, S.J. Oak Ridge National Lab., TN (USA). [1990]. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International symposium on radiation effects on polymeric materials - satellite symposium to the 200th national meeting of the American Chemical Society; Washington, DC (USA); 26-31 Aug 1990. Order Number DE91000559. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Monoclonal antibodies highly specific to the mouse pulmonary endothelial cells were conjugated to liposomes. The resulting immunoliposomes showed high levels of lung accumulation when injected intravenously into mice. Optimal target binding and retention were achieved if the lipid composition included ganglioside GM_1 to reduce the uptake of immunoliposomes by the reticuloendothelial system. Details of the construction and optimization of these organ-specific immunoliposomes are reviewed. The drug delivery potential of this novel liposome system was demonstrated in an experimental pulmonary metastasis model. Immunoliposomes containing a lipophilic prodrug of deoxyfluorouridine effectively prolonged the survival time of the tumor-bearing mice. This and other therapeutic applications of the immunoliposomes are discussed. 25 refs., 5 figs.

51775 (DOE/ER/13257–T1) **[Catalytic mechanism of hydrogenase from aerobic N_2-fixing microorganisms]: Progress report.** Arp, D.J. California Univ., Riverside, CA (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-84ER13257. Order Number DE91000126. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Hydrogenases are enzymes which catalyze reactions involving dihydrogen. They serve integral roles in a number of microbial metabolic pathways. Our research is focussed on investigations of the catalytic mechanism of the hydrogenases found in aerobic, N_2-fixing microorganisms such as Azotobacter vinelandii and the agronomically important Bradyrhizobium japonicum as well as microorganisms with similar hydrogenases. The hydrogenases isolated from these microorganisms are Ni- and Fe-containing heterodimers. Our work has focussed on three areas during the last grant period. In all cases, a central theme has been the role of inhibitors in the characteristics under investigation. In addition, a number of collaborative efforts have yielded interesting results. In metalloenzymes such as hydrogenase, inhibitors often influence the activity of the enzyme through ligand interactions with redox centers, often metals, within the enzyme. Therefore, investigations of the ability of various compounds to inhibit an enzyme's activity, as well as the mechanism of inhibition, can provide insight into the catalytic mechanism of the enzyme as well as the role of various redox centers in catalysis. We have investigated in detail four inhibitors of A. vinelandii and the results are summarized here. The influence of these inhibitors on the spectral properties of the enzyme are summarized. Electron paramagnetic resonance and ultraviolet spectra investigations are discussed. 9 figs.

51776 (LBL–27660, pp. 166-172) **Exciton microscopy and scanning optical nanoscopy.** Kopelman, R. (Univ. of Michigan, Ann Arbor (USA)); Lewis, A.; Lieberman, K. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences*. 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

We describe the development of a new biologically non-invasive ultraresolution light microscopy, based on combining the energy transfer spectral ruler method with the micro-movement technology employed in STM. We use near-filed scanning optical microscopy, with micropipettes containing crystals of energy packaging donor molecules in the tips that can have apertures below 5 nm. The excitation of these tips extends near field microscopy well beyond the 50 nm limit. The theoretical resolution limit for this spectrally-sensitive light microscopy is well below 1 nm.

51777 Development of a database for nucleotide sequences. Fickett, J.W. (Theoretical Biology and Biophysics, Los Alamos National Lab., Los Alamos, NM (US)); Burks, C. pp. 1-34 of Mathematical methods for DNA sequences. Waterman, M.S. CRC Press Inc., Boca Raton, FL (USA) (1989). pp. 282

Computer analysis can greatly aid understanding of DNA sequence data. The sequences are often meaningless to the human eye; there is abundant evidence that humans cannot even copy over a DNA sequence without making frequent errors. Patterns that seem significant when one person looks at five or ten genes often

turn out to be the result of random variation when a larger scale analysis is carried out. To make these data available for significant analysis, one must first gather and organize them into a comprehensive database. Although several specialized computer collections of nucleic acid sequence data are mentioned briefly, the authors focus in this chapter is on general applications of the data and on comprehensive collections. They describe one approach, undertaken by the GenBank staff at LANL (Los Alamos National Laboratory), to the development of a database that does justice to the natural structure of the data, facilitates current applications, and allows expansion for the foreseeable future.

51778 A fiberoptic antibody-based biosensor with time-resolved detection. Vo-Dinh, T. (Advanced Monitoring Development Group, Health and Safety Research Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Nolan, T.; Cheng, Y.F.; Alarie, J.P.; Speaniak, M.J. pp. 266-272 of Chemical, biochemical, and environmental fiber sensors: Volume 1172. Lieberman, R.A.; Wlodarczyk, M.T. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 318 DOE Contract AC05-84OR21400. (CONF-8909177–: O/E Fibers '89: meeting of the International Society for Optical Engineering, Boston, MA (USA), 5-8 Sep 1989).

A phase-resolved fiberoptic antibody-based biosensor is described, which combines the biochemical specificity of antigen-antibody reaction the high sensitivity of laser excitation, the versatility of fiberoptic sensors, and the selectivity of phase-resolved detection. The device can differentiate benzo(a)pyrene and benzo(a) pyrene tetrol, a DNA-adduct product of the carcinogen benzo(a)pyrene. The limit of detection of benzo(a) pyrene tetrol is in the attomole range (10^{-18} moles).

51779 ras Oncogene proteins: Three-dimensional structures, functional implications, and a model for signal transducer. Kim, S.H. (Univ. of California, Berkeley (USA)); de Vos, A.M.; Tong, L.; Milburn, M.V.; Matias, P.M.; Jancarik, J.; Ohtsuka, E.; Nishimura, S. pp. 273-281 of Cold spring harbor symposia on quantitative biology. Volume 53, Molecular biology of signal transduction. The Cold Spring Harbor Laboratory, Cold Spring Harbor, NY (US) (1988). pp. 550 (CONF-8805382–Pt.1: 53. symposium on the molecular biology of signal transduction, Cold Spring Harbor, NY (USA), 25 May - 1 jun 1988).

The authors have recently determined the crystal structures of the catalytic domain of a normal and two transforming c-Ha-ras p21 proteins lacking the flexible 18 residues at the carboxyl termini. They present here features of these crystal structures relevant to the known biochemical properties and functions, describe the differences between normal and transforming p21 proteins in the GDP-bound form, propose a model of the α subunit of G proteins derived on the basis of crystal structure of p21, and suggest a possible mechanism for conformational change on GDP/GTP exchange.

51780 Sequence of the Erysiphe graminis f. sp. hordei gene encoding β-tubulin. Sherwood, J.E. (Michigan State Univ., East Lansing (USA)); Somerville, S.C. *Nucleic Acids Research (UK)*, 18(4): 1052 (25 Feb 1990).

The β-tubulin gene from Eyrsiphe graminis f. sp. hordei race CR3 was isolated from a genomic λ2001 library prepared from conidial DNA, using the Neurospora crassa tub-2 gene as a probe. The deduced E. g. hordei structural gene, which encoded a polypeptide of 446 amino acids, was interrupted by six introns with positional and splice sequence homology to the N. crassa tub-2 gene. The amino acid sequence showed a high degree of homology to other fungal β-tubulins. A major difference between the E. g. hordei gene and the majority of other fungal β-tubulin genes was the lack of codon usage bias observed with the E. g. hordei gene, in which 60 of the 61 sense codons were present. This sequence was the only β-tubulin gene detected in Southern blotting experiments.

51781 Fluorescence line-narrowing spectral analysis of in vivo human hemoglobin-benzo[a]pyrene adducts: Comparison to synthetic analogues. Jankowiak, R. (Iowa State Univ., Ames (USA)); Small, G.J.; Day, B.W.; Skipper, P.L.; Tannenbaum, S.R.; Lu, Peiqi; Doxtader, M.M. *Journal of the American Chemical Society (USA)*, 112(15): 5866-5869 (18 Jul 1990). DOE Contract W-7405-ENG-82.

In order to gain insight as to the structure(s) of the adduct formed in vivo between human hemoglobin and the anti-diol epoxide (anti-BPDE) of benzo[a]pyrene (BaP), a series of model compounds was synthesized to investigate the effect on the fluorescence line-narrowing (FLN) spectra of heteroatom substitution at C-10 in BaP tetrahydrotetrol analogues. Spectra taken at 4.2 K by vibronic laser excitation at both 356.9 and 363.4 nm revealed marked differences between BaP tetrahydrotetrols and synthetic thioether, amino, and ester adducts of anti-BPDE. Use of these same excitation wavelengths on intact human globin samples obtained from individual s environmentally exposed to ambient levels of BaP yielded vibronic FLN spectra that were virtually indistinguishable from those of a synthetic C-10 carboxylic ester derived from anti-BPDE.

51782 Characterization of the structure and melting of DNAs containing backbone nicks and gaps. Snowden-Ifft, E.A. (Lawrence Berkeley Laboratory, CA (USA)); Wemmer, D.E. *Biochemistry (USA)*, 29(25): 6017-6025 (26 Jun 1990).

A DNA molecule containing a gap (a missing phosphate) has been examined and compared to two other molecules of the same sequence, one containing a nick (a phosphorylated gap) and the other a normal duplex containing no break in the backbone. A second gapped sequence was also compared to a normal duplex of the same sequence. The molecules containing nicks or gaps were generated as dumbbell molecules, short helices closed by a loop at each end. The dumbbells were formed by the association of two hairpins with self-complementary dangling 5'-ends. Nuclear magnetic resonance was used to monitor the melting transition and to probe structural differences between molecules. Under the conditions used here no change in stability was observed upon phosphorylation of the gap. Structural changes upon phosphorylation of a gap or closure of a nick were minimal and were localized to the region immediately around the gap or nick. Two transitions can be observed as a gapped or nicked molecule melts, although the resolution of the two transitions varies with the salt concentration. At moderate to high salt (greater than or equal to 30 mM) the molecule melts essentially all at once. At low salt the two transitions occur at temperatures that differ by as much as 15 degrees C. In addition, comparison with other NMR melting studies indicates that the duplex formed by the overlap of the dangling ends of the hairpins is stabilized relative to a free duplex of the same sequence, probably by stacking onto the hairpin stem.

51783 Nucleotide sequence of the triosephosphate isomerase gene from Macaca mulatta. Old, S.E. (Univ. of Michigan, Ann Arbor (USA)); Mohrenweiser, H.W. *Nucleic Acids Research (UK)*, 16(18): 9055 (26 Sep 1988).

The triosephosphate isomerase gene from a rhesus monkey, Macaca mulatta, charon 34 library was sequenced. The human and chimpanzee enzymes differ from the rhesus enzyme at ASN 20 and GLU 198. The nucleotide sequence identity between rhesus and human is 97% in the coding region and >94% in the flanking regions. Comparison of the rhesus and chimp genes, including the intron and flanking sequences, does not suggest a mechanism for generating the two TPI peptides of proliferating cells from hominoids and a single peptide from the rhesus gene.

5503 Cytology

51784 Casein gene expression in mouse mammary epithelial cell lines: Dependence upon extracellular matrix and cell type. Medina, D. (Baylor College of Medicine, Houston, TX (USA)); Oborn, C.J.; Li, M.L.; Bissell, M.J. *Experimental Cell Research (USA)*, 172(1): 192-203 (Sep 1987). DOE Contract AC03-76SF00098.

The COMMA-D mammary cell line exhibits mammary-specific functional differentiation under appropriate conditions in cell culture. The cytologically heterogeneous COMMA-D parental line and the clonal lines DB-1, TA-5, and FA-1 derived from the COMMA-D parent were examined for similar properties of functional differentiation. In monolayer cell culture, the cell lines DB-1, TA-5, FA-1, and MA-4 were examined for expression of mammary-specific and

epithelial-specific proteins by an indirect immunofluorescence assay. The clonal cell lines were relatively homogeneous in their respective staining properties and seemed to represent three subpopulations found in the heterogeneous parental COMMA-D lines. None of the four clonal lines appeared to represent myoepithelial cells. The cell lines were examined for expression of β-casein mRNA in the presence or absence of prolactin. The inducibility of β-casein in the COMMA-D cell line was further enhanced by a reconstituted basement membrane preparation enriched in laminin, collagen IV, and proteoglycans. These results support the hypothesis that the functional response of inducible mammary cell populations is a result of interaction among hormones, multiple extracellular matrix components, and specific cell types.

51785 **Modification of MCDB 110 medium to support prolonged growth and consistent high cloning efficiency of diploid human fibroblasts.** Ryan, P.A. (Michigan State Univ., East Lansing (USA)); Maher, V.M.; McCormick, J.J. *Experimental Cell Research (USA)*, 172(2): 318-328 (Oct 1987).

In preparation for studies on the growth factor requirements of normal and transformed human fibroblasts, we have developed a serum-free medium that supports vigorous long-term serial subculture of diploid human fibroblasts and allows them to form large-sized colonies with high efficiency (40 to 60%) when plated at cloning density. This medium, which is a modification of Ham's MCDB 110 base medium with its serum replacement supplements, is relatively easy to prepare and the cost of the serum replacements is approximately the same as that of fetal bovine serum supplied at 10%. The ingredients of Supplement B of MCDB 110 medium were added in an ethanol solution, rather than in the form of liposomes, and were combined with bovine serum albumin, a lipid carrier. Gelatin and fetuin were included as attachment factors instead of polylysine. Bioassays indicated that none of the ingredients in the medium were contaminated with either epidermal growth factor or platelet-derived growth factor. In this modified serum-free medium, which the authors have designated McM + SR_1, diploid human fibroblasts grew for 21 days at the same rate as in the base medium, McM, supplemented wt 10% FBS. During the next 20 days, they underwent 15 population doublings which was 75% of the rate of cells growing in the medium containing serum.

5504 Genetics

Refer also to citation(s) 51777, 51857

51786 (DOE/ER/60636-3) **Genes and gene expression: Localization, damage and control: A multilevel and interdisciplinary study: Progress report, February 1, 1990-January 31, 1991.** Ts'o, P.O.P. Johns Hopkins Univ., Baltimore, MD (USA). Sep 1990. 33p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER60636. Order Number DE91000880. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The main objectives of this Program Project is to develop strategy and technology for the study of gene structure, organization and function in a multi-disciplinary, highly coordinated manner. In Project I, Molecular Cytology, the establishment of all instrumentation for the computerized microscopic imaging system (CMIS) has been completed with the software in place, including measurement of the third dimension (along the Z-axis). The technique is now at hand to measure single copy DNA in the nucleus, single copy mRNA in the cell, and finally, we are in the process of developing mathematical approaches for the analysis of the relative spatial 3-D relationship among the chromosomes and the individual genes in the interphasal nucleus. Also, we have a sensitive and reliable method for measuring single-stranded DNA breaks which will be useful for the determination of damage to DNA caused by ionizing radiation. In Project II, the mapping of restriction fragments by 2-D enzymatic and electrophoretic analysis has been perfected for application. In Project III, a major finding is that the binding constant and effectiveness of antisense oligonucleotide analogues, Matagen, can be significantly improved by substituting 2'-O-methylribos methylphosphonate backbones for the current 2'-deoxyribomethylphosphonate backbones. 15 refs., 10 figs., 2 tabs.

51787 **A possible role of retrotransposons in carcinogenesis.** Weinstein, I.B. (Columbia Univ. Comprehensive Cancer Center and Institute of Cancer Research, New York, NY (US)); Hsieh, L.; Begemann, M.; Dragani, T.A.; Peraino, C. pp. 289-298 of Eukaryotic transposable elements as mutagenic agents. Lambert, M.E.; McDonald, J.F.; Weinstein, I.B. Cold Spring Harbor Laboratory, Cold Spring Harbor, NY (USA) (1988). pp. 342

Carcinogenesis involves complex changes in gene expression and the strucure of cellular DNA. The DNA of mammalian cells, including humans, contains thousands of copies of endogenous retrovirus-like elements whose structures closely resemble transposable elements found in lower organisms.

5505 Metabolism

Refer also to citation(s) 50666, 51775

51788 **Bioaccumulation of benzo(a)pyrene from sediment by fathead minnows: Effects of organic content, resuspension, and metabolism.** McCarthy, J.F. (Oak Ridge National Laboratory, TN (USA)); Burrus, L.W.; Tolbert, V.R. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA)*, 30(1): 495-498 (1990). DOE Contract AC05-84OR21400. (CONF-900402--: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

It is the objective of this research to examine the interaction of chemical and biological variables that influence the uptake and accumulation of a model contaminant, BaP, by the fathead minnow, Pimephales promelas. Specifically, we examine effects of the organic carbon content (OC) of the sediment on partitioning of BaP into the water and on the rate of ingestion of contaminated sediment, the effect of bioturbation of sediment by fish on the aqueous concentration of BaP in the water column, and the apparent increase in the rate of elimination of BaP in fish receiving higher levels of exposure to BaP from sediment and water.

5506 Medicine

Refer also to citation(s) 50654, 51366, 51367, 51368, 51369, 51370, 51774, 51845, 52234

51789 (AD-A-223779/0/XAB) **Filmless radiology: The design, integration, implementation, and evaluation of a digital imaging network. Final report, 1 March 1986-31 January 1990.** Cerva, J.R.; Kerlin, B.D.; Pocinki, L.S. Mitre Corp., McLean, VA (USA). Jun 1990. 90p. Contract DAMD17-86-C-6145. (MTR-90W00040). Source: NTIS, PC A05/MF A01.

Medical images generated by radiological procedures typically result in the generation of film-based images. In 1986, the U.S. Army Medical Research and Development Command contracted with the MITRE Corporation to investigate the use of filmless radiology in both its fixed facility and battlefield medical systems. To support this evaluation, commercially available Digital Imaging Network System (DINS) equipment was competitively procured and installed at two university medical centers, which competed for the opportunity to participate in this evaluation. Equipment provided by AT&T was installed at Georgetown University and equipment provided by Philips Medical Systems was installed at the University of Washington. In parallel, a prototype battlefield DINS was developed by MITRE, using commercially available workstation technology, to support concept exploration of DINS in the battlefield environment. This document summarizes and presents the results of the systems engineering studies and technical evaluations that were conducted as part of this four-year study.

51790 (BIR-18) **Technical and physical parameters for quality assurance in medical diagnostic radiology: Tolerances, limiting values and appropriate measuring methods.** Moores, B.M. (Radiation Protection Service, Liverpool (UK)); Stieve, F.E.; Eriskat, H. British Inst. of Radiology, London (UK); Commission of the European Communities, Brussels (Belgium). Directorate General for Science, Research and Development; Commission of the European Communities, Brussels (Belgium). Directorate General for Employment, Social Affairs and Education. 1989. 165p. (CONF-8802161--: Workshop on technical and physical parameters for

quality assurance in medical diagnostic radiology: tolerances, limiting values and appropriate measuring methods, Brussels (Belgium), 23-25 Feb 1988; EUR–11620). Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The proceedings of a workshop on Technical and Physical Parameters for Quality Assurance in Medical Diagnostic Radiology are presented. The fifty-one papers presented at the workshop dealt with subject areas covering organizational aspects of quality control, parameters of the image-producing system using conventional x-ray equipment or special equipment and techniques, system analysis and image performance of image-recording systems, retrieval and viewing conditions and dosimetry. Fifty papers are selected and indexed separately. (Author).

51791 (BNL–44480) **Biomedical elemental analysis and imaging using synchrotron x-ray microscopy.** Jones, K.W. (Brookhaven National Lab., Upton, NY (USA)); Gordon, B.M.; Schidlovsky, G.; Spanne, P.; Dejun, Xue; Bockman, R.S.; Saubermann, A.J. Brookhaven National Lab., Upton, NY (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services. DOE Contract AC02-76CH00016. Grant P41RR01838. (CONF-900877–8: 12. international congress for electron microscopy, Seattle, WA (USA), 12-18 Aug 1990). Order Number DE91000901. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The application of synchrotron x-ray microscopy to biomedical research is currently in progress at the Brookhaven National Synchrotron Light Source (NSLS). The current status of the x-ray microscope (XRM) is reviewed from a technical standpoint. Some of the items considered are photon flux, spatial resolution, quantitation, minimum detection limits, and beam-induced specimen damage. Images can be produced by measurement of fluorescent x rays or of the attenuation of the incident beam by the specimen. Maps of the elemental distributions or linear attenuation of the incident beam by the specimen. Maps of the elemental distributions or linear attenuation coefficients can be made by scanning the specimen past the beam. Computed microtomography (CMT) can be used for non- destructive images through the specimen in either the emission or absorption mode. Examples of measurements made with the XRM are given.

51792 (INIS-mf–12120) **The value of soft x-rays in the treatment of plastic induration of the penis.** Kodalle, W. Muenchen Univ. (Germany, F.R.). Medizinische Fakultaet. 26 Jul 1984. 83p. (In German). Order Number DE90706221. Source: NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

When the therapeutic results achieved in 92 patients treated during the period between 1969 and 1981 were analysed, it was found that there were no clearly defined, uniform criteria to evaluate the success of treatment, due to which fact there was basis for comparisons with other studies. Radiotherapy using soft x-rays solely has an indication in patients where the pressure of illness, in particular that at the emotional level, is considerable. In view of the fact that the available methods of treatment appear to be equally effective, any such therapy ought to be adjusted to the requirements of each individual patient and the severity of the disease and carried out in such a way that the risk of complications is kept to a minimum. Treatment with soft x-rays is particularly suitable in the initial stages of the disease, when the patients mainly complain of pain and painful cohabitation and appears to be more promising in youngish men. Clinicians should be cautious not to exceed a total dose of 2400 rad.

51793 (INIS-mf–12121) **Serial computed tomography and its uses in the diagnosis of pathological changes in the liver, pancreas and kidneys.** Schmiedel, R. Freie Univ. Berlin (Germany, F.R.). 8 Jul 1983. 124p. (In German). Order Number DE90706222. Source: NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The investigations described were carried out in such a way as to fulfil the defined requirements of serial computed tomography like short periods of measurement, high scanning frequency and intravasal bolus injection of a contrast medium that would readily be excreted by the renal route. In this connection, the following questions were of particular interest: 1. Is computed serial tomography able to provide better clues to tissue identification and the distinction between normal and pathological structures in the liver, pancreas and kidneys? 2. Would it be possible to obtain information as to the degree of vascularisation in space-occupying pathological processes in the liver, pancreas and kidneys? 3. Is serial computed tomography a useful tool to diagnose specific pathological changes in the liver, pancreas and kidneys? 4. Would this investigation permit predictions to be made about the functional performance of the liver, pancreas and kidneys?

51794 (INIS-mf–12122) **Post-mortem radiography of the lungs: Experiments to compare various methods of examination and descriptions of their usefulness in actual practice.** Pankow, W. Marburg Univ. (Germany, F.R.). Fachbereich 20 - Humanmedizin. 11 Jul 1986. 98p. (In German). Order Number DE90706223. Source: NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Described is the post-mortem examination of the isolated lung using radiologic-morphologic and histologic methods. Comparisons are made ragarding practical value of the conservation techniques chosen, which were the method of Markaria and Heitzmann that is based on fixing in alcohol and air drying and the nitrogen freezing method developed by Rau and colleagues. Both methods ensure adequate visualition of the pulmonary ultrastructure by x-rays, even though this observation should be qualified by the fact that pulmonary tissue fixed in alcohol tends to shrink and that intraalveolar edema are thus artificially reduced. Either of the methods under investigation permits angiographic and bronchographic examinations to be carried out without difficulty. In macroscopic evaluations better results are obtained for lungs fixed in alcohol. Freeze-dried samples offer advantages in the histological assessment of the pulmonary ultrastructure. Post-mortem radiography of the lungs is particularly valuable in the analysis of pathological changes in the pulmonary structure.

51795 (INIS-mf–12123) **Experimental study on the hydroxyproline content of enteroanastomoses established in irradiated intestines of rats.** Winter, S. Freie Univ. Berlin (Germany, F.R.). 14 Aug 1984. 163p. (In German). Order Number DE90706224. Source: NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Cross-bred Sprague-Dawley rats were subjected to percutaneous x- irradiation of the rectosigmoid using a split-dose regimen and focal dose of 50 Gy. One day as well as one, two and four months after the cessation of irradiation a termino-terminal anastomosis was established in the era exposed to radiation. On days 3, 7, 14, and 21 after surgery those parts of the intestine, which had been united by anastomosis, were removed in order to determine the hydroxyproline content of the latter. Further determinations were made in specimens of the tissue 1 cm above the anastomosis and carried out before surgery, after intraperitoneal injection of the anaesthetic alone or in animals subjected to laparatomy including intestinal exposure, where no anastomosis was established. In general, the collagen levels determined in colon anastomoses of irradiated or non-irradiated intestines of rats did not point to any adverse effects from radiation on the healing process. This result appears to be largely consistent with the experiences so far gained at the clinical level in the preoperative irradiation of colon carcinomas.

51796 (INIS-mf–12125) **Quantitative evaluations in planar myocardial scintigraphy using 201-thallium.** Kaiser, J.W. Tuebingen Univ. (Germany, F.R.). Medizinische Fakultaet. 1987. 73p. (In German). Order Number DE90706225. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The observation that the judgements of myocardial images obtained by 201-thallium scintigraphy tend to vary considerably between investigators has prompted us to develop two versions of a quantitative evaluation technique which – after orthogonal-polar adjustment of the coordinates (with the centre of the left ventricle being the origin of the coordinate system) – would allow the counting rates to be expressed as goniometric functions and shown in graphs. The methods under investigation did, however, not appear to give reasonable approximations to a 'normal range', on the

basis of which it would be possible to make clearer distinctions between scintiscans with and without pathological findings.

51797 (INIS-mf–12126) **Beneficial and adverse effects of irradiation in patients repeatedly subjected to high-dosage treatment.** Roeckelein, I. Erlangen-Nuernberg Univ., Erlangen (Germany, F.R.). Medizinische Fakultaet. 10 Nov 1986. 115p. (In German). Order Number DE90706226. Source: NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

During the period between 1978 and 1983 a total of 156 patients showing different types of tumors were subjected to high-dosage radiotherapy. The patients were treated repeatedly for primary or recurrent tumours using a radiation dose of >79 Gy. Each of the three largest groups, which were mammary carcinomas (33), cerebral tumours (25) and orohypopharyngeal tumours (22), was analysed individually. In the majority of patients the local effects of this radiotherapy were such that total or at least partial remission of the primary or recurrent tumour appeared most likely. In the groups receiving doses in the lower range the results were just as good as those achieved in subjects exposed to high doses. The survival times determined here for bearers of mammary or cerebral carcinomas were better than the relevant values given in the literature.

51798 (INIS-mf–12127) **Long-term study on the radiotherapy of squamous cell carcinomas confined to the vocal cord.** Legner, R. Wuerzburg Univ. (Germany, F.R.). Medizinische Fakultaet. 21 Jul 1983. 44p. (In German). Order Number DE90706227. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It was the aim of this study to compare two different methods of treating carcinomas of the vocal cord, which are ultrahard x-rays or telecobalt on the one hand and radium contact irradiation on the other hand. A clear definition of the therapeutic role of these two techniques is an urgent requirement, in particular in view of the fact that the relative advantages of a radiotherapeutic management of carcinomas of the vocal cord must in each case be carefully balanced against those of surgical intervention.

51799 (INIS-mf–12129) **Structural identification and characterization of monoclonal antibodies to rat angiotensinogen.** Nagel, M. Heidelberg Univ. (Germany, F.R.). Naturwissenschaftlich-Mathematische Gesamtfakultaet. 25 Oct 1984. 102p. (In German). Order Number DE90706228. Source: NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

Balb/c mice were immunised in vivo using angiotensinogen obtained from rats. In order to confirm that an immunoreaction had taken place, the concentration of specific antibodies was determined in selected sera on the basis of a radioimmunological method. In view of the fact that affinity of the antibodies of the three monoclonal lines isolated here was calculated to be in the order of $10h^7$ l/mol it appears that their main field of use in affinity chromatography would be the purification of angiotensinogen from rats.

51800 (LBL–27660, pp. 1-5) **Chromatin structure and x-ray imaging: Static and dynamic considerations.** Gray, J.W. (Lawrence Livermore National Lab., CA (USA)); Trebes, J. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Substantial effort in genetics is now being devoted to determination of the entire sequence of nucleotides for humans and other organisms and investigation of mechanisms that control the replication and translation of DNA. X-ray imaging may play a role in both areas; high resolution analysis may provide information about the DNA sequence itself and intermediate resolution imaging may provide information about the organization of DNA in living cells that may be important to the regulation of replication and gene expression. This paper provides information about DNA structure and organization that may be useful as a guide to the design of X-ray imaging experiments.

51801 (LBL–27660, pp. 6-7) **Research directors in DOE'S life science programs.** Goldstien, G. (Dept. of Energy, Washington, DC (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

The Office of Health and Environmental Research (OHER) is the life sciences research arm of the Department of Energy. The OHER program has two main objectives: (1) to develop the knowledge base necessary to identify, understand, and anticipate the long-term health and environmental consequences to energy use and development; and (2) to utilize the Department's unique scientific and technological capabilities to solve major scientific problems in medicine and biology. In addition to science oriented research aimed at improving our fundamental understanding in areas important to OHER objectives, several large scale multidisciplinary efforts have been mounted addressing key programmatic and societal issues that require a well organized and integrated approach involving a variety of scientific specialties. Some examples are: Human Genome Program; Structural Biology; Radon Research Program; Acid Rain; Global Climate Change and Subsurface Science Program. We anticipate that with the development of new high brightness, coherent synchrotron light sources, and x-ray lasers microimaging techniques will make an important contribution in structural biology research particularly in determining the three-dimensional structure of biological cells and subcellular components.

51802 (LBL–27660, pp. 8-14) **Organization, structure and function of chromosomes.** Bradbury, E.M. (Univ. of California, Davis (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Although much interest focuses on the mapping and sequencing of genes, non-coding DNA regions clearly contain sequences involved int he organization and functions of chromosomes. The constancy of banding patterns of individual metaphase chromosomes reflects a highly reproducible pattern of long-range DNA folding, most probably directed by specific DNA-protein interactions and possible by unusual DNA structure. Superimposed on this long range order is the packaging of the DNA loops, which involves mainly the histones together with other poorly defined structural and regulatory proteins. A major biological question is how the different packagings of loops might determine the states of different genes families. DNA control regions of active genes must be accessible to gene regulatory proteins whereas regulatory regions of the permanently repressed genes of a particular cell type may be packaged so that they are inaccessible. Such packaging may also determine the availability of DNA regions to chemical damage. Thus, a knowledge of the organization of chromosomes is essential to an understanding of the central processes of differentiation and development as well as the processes of DNA damage in chromosomes. Such information is also essential to the ultimate understanding of chromosome organization in the cell nucleus. It is to be hoped that the x-ray imaging capabilities of the Advanced Light Source will provide images of hydrated chromosomes and nuclei at resolutions down the 10-0 nm.

51803 (LBL–27660, pp. 15-20) **Introduction to x-ray imaging methods.** Sayre, D. (IBM Research Center, Yorktown Heights, NY (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

X-rays have the potential of imaging whole biological cells at nanometer resolution. To realize this potential, high-resolution x-ray imaging techniques suitable for the imaging of general specimens are needed. At present, the only high-resolution x-ray techniques are those of x-ray crystallography and are limited to special types of specimens. This paper provides an introduction to the status and possible future of general high-resolution x-ray imaging methods. Basically the situation is that focussing systems, which are the basis for high-resolution imaging with light and electrons, also exist for x-rays but due to the short wavelengths involved require extremely accurate fabrication. Resolutions at present are near 300A, with

100A regarded as possible in the next few years. To supplement these, methods of imaging which do not use focussing are also being studied. Ultimate resolutions to 30A for focussing methods, and possibly to 10A for non-focussing methods, can be envisaged. These numbers refer to purely optical limitations, however, and resolutions will inevitably be affected by radiation damage as well.

51804 (LBL–27660, pp. 21-41) **Brightness, coherence and imaging at x-ray wavelengths.** Attwood, D. (Univ. of California, Berkeley (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Biological imaging utilizing scanning x-ray microscopy has recently achieved two significant milestones: (1) spatial resolution well beyond that of the visible light microscope, and (2) images of biologically viable samples in a wet and unmodified state (neither fixed, sectioned not stained). The goal of this microscopy effort is to study a model biological process – that of secretion – with a space-time dynamic capability not previously possible. The tradeoffs between resolution and damage, determinations of short-term functional viability, careful radiation budgeting and microscope engineering will determine the eventual success of this effort.

51805 (LBL–27660, pp. 42-47) **Revolution in x-ray optics.** Ceglio, N.M. (Lawrence Livermore National Lab., CA (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

In the past half decade or so there has been a technological revolution in our ability to generate, control, manipulate, focus, and detect x-rays. The emergence of x-ray lasers and synchrotron insertion devices has increased the brightness of laboratory x-ray sources eight to twelve orders of magnitude over what was available in the late 1960's. In addition, the past few years have been witness to significant advance in the development of normal incidence x-ray mirrors and beamsplitters, diffraction limited x-ray lenses, x-ray microscopy, x-ray holography, x-ray waveguides, and CCD x-ray detector arrays. Utilizing these new capabilities, workers in the field are taking the first steps toward the development of sophisticated soft x-ray optical systems, including soft x-ray interferometers high intensity x-ray lasers and projection optics for x-ray lithography. Details of these developments are discussed in the references listed below. Highlight of the oral presentation are provided.

51806 (LBL–27660, pp. 48-50) **Direct x-ray microimaging.** Kirz, J. (SUNY, Stony Brook, NY (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

X-ray microimaging may be classified into two basic approaches, direct and diffractive imaging. There are several contributions to this workshop concerning diffractive imaging, such as Gabor and Fourier transform holography, and soft X-ray diffraction. In this contribution we provide a brief review of the direct imaging methods, their relative merits, and speculate about future directions of the field.

51807 (LBL–27660, pp. 51-56) **Radiation damage and its influence on source requirements for high resolution x-ray holography.** London, R.A. (Univ. of California, Berkeley (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

This paper outlines the talk given at the conference on X-ray Microimaging for the Life Sciences held May 24-26, 1989 in Berkeley, California. Soft x-ray holography offers the possibility of obtaining high resolution, 3-D images of living cells and organelles therein. To achieve a specified resolution, a certain number of photons must be scattered by the smallest features of interest within the samples. This requires a certain irradiating fluence, the magnitude of which depends on the wavelength of the x-rays and the scattering cross-sections of the features. Unfortunately, irradiation of the sample will be accompanied by the absorption of x rays. If the dose is large, the sample will be damaged, possibly compromising the quality of the image. A theoretical study of the scattering and absorption of x rays during the creation of a hologram is described. Using a new prescription for scattering by condensed biological materials within the aqueous environment of a cell, we estimate the irradiating fluence required for a certain resolution and the associated sample dose. The relative merits of different x-ray wavelengths are discussed. A wavelength of about 44 Å, just outside the water window, appears to be optimal in that the required fluence and dose are minimized, while reasonable x-ray penetrability is maintained. Estimates are given for the minimum source energy required and the maximum duration of an exposure to capture an image before blurring due heat induce motion. The use of colloidal gold tagging can enhance image contrast and reduce the required irradiating fluence and sample damage.

51808 (LBL–27660, pp. 57-68) **New biological science with x-ray microimaging.** Rothman, S. (Univ. of California, San Francisco (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

X-ray microimaging represents a comparative method that will both permit us to look at the structures of the cell in a new light, x-radiation, and without the major alternations in the sample required by common electron microscopy. Unlike electron microscopy, x-ray imaging is suited for viewing a wide range of biological structures in their natural state; that is, in the absence of fossilizing preparative procedures or other alterations, save extraction from the tissue or cell of origin. X-ray imaging allows the environmental conditions that are prerequisite for useful dynamic imaging of biological material. The sample can be kept in an aqueous environment at body temperature, whole, and without the addition of foreign substance, such as heavy metals or dyes, to provide imaging contrast. Where proper resolution is not the criterion of merit, one should be able to examine features beyond the resolution limit of x-ray microimaging in much the same way as has been done with visible light microscopy, offering the possibility of gaining information as to location and relative motion of very small objects.

51809 (LBL–27660, pp. 69-79) **X-ray holography: Early experience in microimaging.** Jacobsen, C. (Lawrence Berkeley Laboratory, CA (USA)); Howells, M.; Bastacky, J.; Rothman, S. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

The authors have recently recorded holograms using 19 Å x-rays from the X-1A undulator beamline at the National Synchrotron Light Source. Coherent illumination is obtained through the use of a monochromator and pinhole arrangement, and we can now record holograms with an exposure time of about three minutes. An image of 1.09 μm polystyrene spheres is obtained by numerically reconstructing an x-ray hologram. The spheres appear to be structureless objects, and the image is only slightly corrupted by the twin-image noise inherent in the Gabor holographic geometry. The lack of internal structure in these spheres has been confirmed by viewing them in a 1.5 MeV high voltage transmission electron microscope (HVEM). These images suggest that we can indeed obtain essentially artifact-free images of organic materials.

51810 (LBL–27660, pp. 74-79) **Computational and visible light experiments for X-ray laser holography.** Brase, J.M. (Lawrence Livermore National Lab., CA (USA)); Yorkey, T.J.; Peters, D.C. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Due to the fact that most biological objects of interest are embedded in a complex three-dimensional environment, it is difficult to estimate the usefulness of x-ray images of complex objects using usual measures of resolution such as Rayleigh criteria. We are approaching this problem for the design and characterization of x-ray holography systems by developing computational tools for the simulation of x-ray hologram formation and for their computational reconstruction. These efforts are closely coupled with a scaled visible light experimental program which validates both the stimulations and the reconstruction techniques. The use of simulations allows us not only to establish resolution limits for complex objects but also to vary the parameter space in a controlled manner to optimize imaging system designs.

51811 (LBL–27660, pp. 80-84) **Genome sequencing by direct imaging x-ray color holography.** Haddad, W. (MCR Technology Corporation, Chicago, IL (USA)); Boyer, K.; Solem, J.C.; Rhodes, C.K.; Moriarty, R.M. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Currently available techniques for sequencing DNA are inadequate for oligonucleotides of length greater than 600 nucleotides and are most effective in the 300 nucleotide range. Since the full human genetic complement is of vast size, representing $\sim 3 \times 10_9$ bases, a fast and accurate method for DNA sequencing is needed. Therefore, we set as a goal a sequencing rate in the range of $\approx 10^2$ bp/s with an accuracy of ~ 1 error per 10^6 bases, a value exceeding that set by the fidelity of current enzymatic processes. These values would permit the accurate determination of the sequence of the full human genome in one year. An approach involving rapid direct imaging of large segments of DNA is desired. A properly constructed x-ray Fourier-transform holographic microscope appears to combine these features. A basic x-ray holographic instrument has been designed. This concept, with appropriate modifications, and the use of presently available x-ray sources, appears applicable to the task of genome sequencing with a resulting rate of sequence determination in the range of $\sim 10_2$ bp/s.

51812 (LBL–27660, pp. 103-106) **Time-resolved macromolecular crystallography.** Moffat, K. (Cornell Univ., Ithaca, NY (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Much of our knowledge of the fundamentals of molecular biology comes from analysis of the three-dimensional structure of macromolecules, obtained largely by x-ray crystallographic investigations and more recently, also by two-dimensional nuclear magnetic resonance techniques. Although this approach is achieving notable successes, it has a major limitation. Conventional crystallographic techniques can probe only static structures, and yield a space average over all molecules in the crystal, typically 10^{13} in number, and a time average over the duration of the x-ray exposure. However, the heart of biological processes such as catalysis, during binding, viral uncoating, antigen-antibody recognition, and muscle contraction lies in dynamic changes in structure that extend over a very wide time range, rather that in static structure. How are these dynamic changes in structure to be observed? Techniques are needed that can probe atomic structures in real time, as the biological process is unfolding: time-resolved crystallography. A time-resolved crystallographic experiment has three main components: reaction initiation, reaction monitoring and time-resolved x-ray data acquisition, and data analysis. These components are discussed.

51813 (LBL–27660, pp. 114-121) **The requirements for improvement in biological microscopy.** Pawley, J.B. (Univ. of Wisconsin, Madison (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Striking technical advances in X-ray sources and X-ray optics now make it possible to produce X-ray images under conditions thought impossible only a few years ago. However, major questions remain as to whether this new instrumentation can find useful application in elucidating biological structure. On the whole, given the sampling problem (implied by the immense cost of the sources needed for X-ray microscopy) the lack of any significantly new contrast mechanisms, the relative inefficiency of the lenses and detector system, and the strong competition from other microtechniques, it is hard to identify a potentially useful role for X-ray microscopy in biology at this time.

51814 (LBL–27660, pp. 122-126) **High Brightness x-rays from undulators and wigglers.** Winick, H. (Stanford Synchrotron Radiation Laboratory, CA (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Electrons in circular motion at low velocity emit radiation in a non-directional pattern. At velocities approaching the velocity of light the radiated power increases dramatically and the pattern is folded forward into a cone with a full opening angle of approximately $2\gamma^{-1} = 2mc^2/E$, where mc^2 is the rest mass energy of the electron (0.51 MeV) and E is the total energy. The opening angle is only 1 milliradian for an electron energy of 1 GeV and correspondingly smaller at higher electron energy. Thus synchrotron radiation has intrinsically high brightness (flux per unit source area per unit solid angle). This geometrical property is exploited differently when the source is a bending magnet, a wiggler, or an undulator. The total power radiated is given by $P(\kappa W) = 1.267E^2\ (GeV)I(A) < B^2(T) > L(m)$ where $< B^2\ (T) >$ is the magnetic field in Tesla averaged over the length L in meters, allowing for constant fields (bending magnets) or alternating (wiggler and undulator magnets). For sinusoidal fields $<B^2>$ is replaced by $B_0{}^2/2$, where B_0 is the peak field.

51815 (LBL–27660, pp. 127-131) **Review of x-ray lasers.** Skinner, C.H. (Princeton Univ., NJ (USA)); DiCicco, D.S.; Kim, D.; Meixler, L.; Nam, C.H.; Tighe, W.; Suckewer, S. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

This study will describe progress to date in the field of x-ray lasers and the application of the soft x-ray lasers and the application of the soft x-ray lasers to microscopy. Soft x-ray lasers offer unique features which complement other light sources and microscopic techniques. We will describe the different techniques for generating a population inversion and producing an soft x-ray laser and review the progress to date and near term prospects in increasing the output power and progressing to shorter wavelengths. We want to stress that we don't see this as a competition between the different techniques. Getting detailed information about life processes inside cells is a challenging task and the more techniques available to obtain that information the better.

51816 (LBL–27660, pp. 132-141) **The development of coherent x-ray lasers for x-ray holography.** Matthews, D.L. (Lawrence Livermore National Lab., CA (USA)); Trebes, J.; London, R.; Rosen, M. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

We will describe several of our research paths to develop an x-ray laser capable of producing the flux required to obtain x-ray holograms of biological structures in live cells. These paths include optimization of our current Ni-like Yb laser which operates at 5.02 nm as well as the introduction of a new Ni-like Ta laser which operates at 4.48 nm, i.e., is the near optimum wavelength for holographic imaging of biological objects. Current predictions indicate that we will need to produce at least 20 μJ of spatially-coherent radiation in a pulselength of 50 psec and focussed at the sample to a beam of 10 μm diameter. We will provide a detailed description of how we hope to meet these requirements. In addition, some

comments will be given on future trends in x-ray laser development, namely towards more efficient table top systems.

51817 (LBL–27660, pp. 142-148) **Feasibility/biological applications of neutron microscopy.** Drukier, A.K. (Univ. of Maryland, College Park (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

The neutron microscope is a new instrument permitting a better understanding of life processes at subcellular levels, e.g., in genetics, cell biology, physiology and pharmacology. New knowledge and understanding of biological functions at the organ and organism level are possible, e.g., real time, high spatial resolution distribution of nitrogen. The neutron microscopes using cold neutrons were built in W. Europe and the USSR, but their performances are severely limited by existing neutron detectors. To obtain submicron spatial resolution and to shorten the time necessary to obtain the image, we suggest the use of a new high spatial resolution imager: The superconducting granular detector (SGD). Using cryogenic techniques neutron detector with a few micron spatial resolution (2048 X 2048 pixels) can be developed and would permit the neutron microscopy with submicron resolution.

51818 (LBL–27660, pp. 158-165) **Status of the plasma focus source for the laboratory type imaging microscope.** Neff, W. (FhG-Institut fuer Lasertechnik, Steinbachstr, Aachen (West Germany)); Holz, R.; Richter, F.; Leber, R. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

A plasma focus operating in nitrogen is developed as an x-ray source for the laboratory type x-ray microscope. The radiation has to be emitted into the water window (2.4 nm - 4.4 nm) with a reciprocal relative bandwidth (RDB) of $\lambda/\delta\lambda > 200$. The nearly coinciding Lyman-α line of nitrogen VII λ = 2.48 nm and the second resonance line of nitrogen VI at λ = 2.49 nm are chosen. For the use in the microscope the end on diameter of the source has to be about 200 μm with a spatial jitter below 100 μm. A first version of the source including beamline and condenser stage has been tested. Spatial, temporal and spectral properties of the source have been investigated. With a pinhole-grating spectrograph spatial and spectral information are obtained simultaneously. First experiments with Fresnel condenser ozone plates (CZP) as a tool for plasma soft X-ray emission diagnostics are presented. Experimental results show that the gas in the beamline can be used as a filter for undesired radiation. With improved efficiency of the zone plates and x-ray detectors the expected plasma emission of about 1 J into the full solid angle from a source with a diameter of 200 μm should be sufficient to achieve an exposure with one pulse.

51819 (LBL–27660, pp. 174-177) **Microscopy with x-ray lasers.** Rosser, R.J. (Princeton Univ., NJ (USA)); DiCicco, D.S.; Skinner, C.H.; Suckewer, S. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

This study will describe the progress to date in applying the soft x-ray laser to imaging biological specimens. X-ray lasers offer the exciting prospect of enabling the study of dynamic processes in living cells. This arises naturally from the nanosecond duration of the soft x-ray laser pulse. One would sequentially take many flash images of living cells and later order them to form the sequence of action. The individual cells would not survive the exposure but radiation damage to structures inside the cell would not change their shape during the nanosecond exposure times. There are many processes occurring on millisecond time scales that would be ideal subjects for a flash image using a pulsed x-ray laser. Of course there is a high intensity limit beyond which the cell becomes a laser produced plasma and all structural information is lost, but this is only a significant problem at resolutions approaching the molecular level.

51820 (LBL–27660, pp. 178-183) **Short wavelength FELs as high brilliance sources.** Shay, H.D.; Barletta, W.A.; Yu, S.; Scharlemann, E.T.; Schlueter, R.; Deis, G. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

The concept of using a high gain FEL amplifiers with electron beams accelerated in high gradient structures powered by relativistic kylstrons is presented. Other authors have also considered x-ray FELs; the unique aspect of this paper is the use of high gradient acceleration. The wavelength, power, and pulse width requirements stem from the objective of viewing biological structures in an aqueous environment with tomographic or holographic microscopy having resolution of several tens of nanometers over a field of view of about ten microns. London, et al., have shown that the greatest ration of signal to dose occurs at a wavelength of about 44Å, at the carbon K-edge and that, at this wavelength, scattering from a protein sphere of 15nm diameter has a cross section of about 10^{-14}cm^2. For adequate signal strength, about 1000 photons should be scattered per solution element. These numbers imply that the incident x-ray fluence should be about 10^{18}photons/cm^2, about 45J/cm^2. The energy absorption resulting from this fluence is so great that significant blurring would occur if the exposure were any longer than about 30ps. With the FEL architecture under consideration here, the natural pulse length is 1-10ps, and so the required FEL peak power would be about 5-50MW.

51821 (LBL–27660, pp. 185-196) **The potential of PEP as a high-brightness soft x-ray source for coherence and micro-imaging studies.** Tatchyn, R. (Stanford Univ., CA (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

The Stanford Positron Electron Project (PEP) offers a number of technical advantages that, if properly exploited, can make it the brightest and most versatile soft x-ray source in the world for research in coherence and micro-imaging. Among these advantages are (1) the existence of long straight sections and high operating energies, which allows the development and installation of advanced weak-field undulators for versatile, polarized soft x-ray generation; (2) a possible emittance upgrade, utilizing a damping wiggler lattice, which would yield emittances of a fraction of 1 nm-rad, leading to the emergence of a new, coherent, mode of spontaneous synchrotron radiation (SR) emission; and (3) the possibility of applying longitudinal pulse compression techniques to possibility of applying longitudinal pulse compression techniques to lengths, greatly enhancing the temporal resolution of single-shot x-ray imaging. In this presentation, these and other features of PEP are graphically presented, and a brief enumeration and discussion of their application to advanced research in x-ray coherence and micro-imaging technology is given.

51822 (LBL–27660, pp. 197-202) **Super-high resolution holographic composite polymer grafts for XUV applications.** Savant, G. (Physical Optics Corporation, Torrance, CA (USA)); Jannson, T. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

Advancement of holographic technology into the XUV brings with it many technical challenges. The resolution, optical quality and environmental stability of holographic materials become crucial issues at shorter wavelengths. Recent developments of a new class of XUV holographic materials based on graft concepts at Physical Optics Corporation (POC) point the way toward development of XUV holographic optical elements featuring high efficiency, high optical quality, conventional and unconventional functions, strong resistance to adverse environments and cost effectiveness.

51823 (LBL–27660, pp. 184) **X-ray microscope with free-standing zone plates at UVSOR (Japan).** Kihara, Hiroshi (Jichi Medical School, Minamikawachi, Tochigi (Japan)); Shimanuk,

Yoshio; Kawasaki, Kenzo; Watanabe, Noric; Taniguch, Mieko; Tsuruta, Hirotsugu; Nagai, Yoshinori; Watanabe, Yutaka; Ogura, Shigetaro. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192--: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

To develop X-ray microscope in VUV region, the use of a free standing zone plate is inevitable. Thus, we have fabricated free-standing zone plate, and tested its focal an magnifying features. The test system was applied for the observation of mesh and dried biospecimens such as diatoms. The present characteristics of the zone plates are: n=312, f=150 mm at 8 nm light, dr_n= 0.93 μm, and Au thickness = 2 μm with a central mask of 0.2 mm as a condenser zone plate. The same dimensional zone plate without masks was used as a micro zone plate. We have tested zone plate imagings with two types of set-ups. One is with a plant-grating monochromator and a zone plate with central mask at the beam line 6A2 of UVSOR, and the other is with the zone plates (with and without a mask) without a monochromator beam line 8A of UVSOR was used. Detectors (MCP or films) were located 2863.5 mm from MZP, which has a magnification ratio 13.4, unless otherwise stated. MEM or Minicopy films were used. Two types of MCP were used with a singled layer or double layers. Obtained images were observed on fluorescent screen, which was usually monitored with SIT camera for accumulation. The Cu No. 1000 mesh image and other biological samples were taken.

51824 (LUMEDW-MEXL-1021-1990) **Diagnostic and interventional radiology in gynecologic neoplasms.** Thorvinger, B. Lund Univ. (Sweden). Dept. of Diagnostic Radiology. May 1990. 18p. Order Number DE91604398. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The role and clinical value of the modern radiologic methods for evaluation of gynecologic tumors is not finally settled. The aims of our investigation were therefore to compare clinical examination with CT in patients with possible recurrence of cervical carcinoma; to evaluate the usefulness of CT in patients with fistulas following gynecologic tumors or their treatment; to evaluate the ability of transabdominal US and MR imaging in intrauterine staging including myometrial invasion on patients with endometrial carcinoma; to evaluate CT in the capacity of monitoring therapy response, probable recurrence or clinical remission in patients with ovarian carcinoma; and to evaluate the effect of intraarterial occlusion in facilitating surgery and in evaluating the role of the intraarterial infusion in gynecologic tumors otherwise refractory to all therapy given. CT was more accurate (91%) than clinical pelvic examination (78%) in revealing extensive disease after radiation and/or surgical treatment. CT was also a most valuable tool in demonstrating genital fistulas following gynecologic malignancy or its treatment. Transabdominal US did not improve staging in early endometrila carcinoma while MR had potential for delineating intrauterine tumor growth (accuracy for myometrial invasion 95%). CT was most valuable in the evaluation of therapeutic response of ovarian malignancy. For possible recurrence or in clinical remission, only positive CT was of clinical significance. The potentials of transcatheter intraarterial management in order to facilitate operability are also discussed. (92 refs.).

51825 (ORNL/FTR-3749) **[Coordinated research programs in nuclear medicine]: Foreign trip report, September 8, 1990-September 17, 1990.** Knapp, F.F. Jr. Oak Ridge National Lab., TN (USA). 3 Oct 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000875. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler visited the Clinic for Nuclear Medicine at the University of Bonn, West Germany, to review, organize, and plan collaborative studies. He also met with the editorial board of the journal NucCompact – European/American Communications in Nuclear Medicine, on which he serves as US editor. He also visited colleagues at the Cyclotron Research Center (CRC) at the University of Liege, Belgium, to coordinate clinical applications of the ultrashort-lived iridium-191m radionuclide obtained from the osmium-190/iridium-191m generator system. The traveler planned and coordinated continuing collaboration with colleagues at the CRC for further applications of this generator system. He also visited the University of Metz, Metz, France, to organize a three-center project for the synthesis and evaluation of various receptor-specific cerebral imaging agents, involving the Oak Ridge National Laboratory (ORNL), CRC, and the University of Metz.

51826 Uptake of a certain nidocarboranyl porphyrin by human glioma xenografts in athymic nude mice and by syngeneic ovarian carcinomas in immunocompetent mice. Kahl, S.B. (Univ. of California, San Francisco (USA)); Joel, D.D.; Nawrocky, M.M.; Micca, P.L.; Tran, K.P.; Finkel, G.C.; Slatkin, D.N. pp. 149, Paper INOR 513 of American Chemical Society, Division of Inorganic Chemistry. American Chemical Society, Washington, DC (US) (1990). pp. 229 (CONF-900402--: 199. national meeting of the American Ceramic Society, Boston, MA (USA), 22-27 Apr 1990).

We report strategies for the synthesis and testing of a certain tetraphenylporphyrin bearing four $B_9C_2H_{11}^-$ cages linked by anilide bonds to the ortho ring positions (BTPP). Boron uptake was measured in human gliomas xenografted into athymic nude mice and in syngeneic ovarian carcinomas in immunocompetent mice treated with BTPP by slow infusion. Bulk boron concentrations up to 34 μg glioma and 45 μg/g carcinoma were observed, and were accompanied by moderate hepatoxicity and thrombocytopenia. These studies further characterize BTPP as a candidate boron transport agent for boron neutron capture therapy (BNCT) of human gliomas and perhaps other malignancies.

51827 Single photon emission computed tomography. Budinger, T.F. (Div. of Research Medicine and Radiation Biophysics, Lawrence Berkeley Lab., Univ. of California, Berkeley, CA (US)). pp. 108-127 of Diagnostic nuclear medicine. Second edition: The challenge for the next decade. Volume 35. Gottschalk, A.; Hoffer, P.B.; Potchen, E.J.; Berger, H.J. Williams and Wilkens, Baltimore, MD (USA) (1988). pp. 1154

This chapter presents an explanation of emission tomography by describing longitudinal and transverse section tomography. In principle all modes of tomography can be considered under the general topic of coded apertures, wherein the code ranges from translation of a pinhole collimator to rotation of a parallel hole or focused collimator array. Single photon emission computed tomography and positron emission tomography comprise emission tomography. Single photon tomography uses collimator systems for detection of gamma photons from radionuclides, and is divided into longitudinal or limited-angle tomography and transverse section tomography. The majority of new developments and practical applications use transverse section tomography, which gives results similar to those of PET and shares with PET the physical problems of attenuation, angular sampling requirements, nonuniformity of resolution, scatter, and statistical limitations. The severity of these problems is greater for SPECT than for PET; however, they can be compensated for through instrument design and mathematical treatment of the data.

51828 Pediatric cardiovascular nuclear medicine. Kuruc, A.R. (Children's Hospital, Harvard Medical School, Boston, MA (US)); Treves, S. pp. 414-426 of Diagnostic nuclear medicine. Second edition: The challenge for the next decade. Volume 35. Gottschalk, A.; Hoffer, P.B.; Potchen, E.J.; Berger, H.J. Williams and Wilkens, New York, NY (USA) (1988). pp. 1154

This paper reports on pediatric first-pass radionuclide angiocardiography, used primarily for the detection, localization, and quantitation of circulatory shunting. This examination provides information regarding gross anatomy and blood flow patterns. Other quantitative applications of this procedure include estimation of ventricular volumes and ejection fractions, cardiac output, and transit times between the various cardiopulmonary structures. The procedure is minimally invasive, carries almost no risk, does not produce significant hemodynamic disturbance, and delivers a low dose of radiation. It is therefore useful as a screening test, prior to more invasive diagnostic procedures, and as follow-up test that may be used repeatedly to follow patients on a long-term basis. The use of portable gamma camera computer systems allows the study to be performed at bedside, if necessary.

51829 Graphical analysis of reversible radioligand binding from time-activity measurements applied to [N-^{11}C-methyl]-(-)-cocaine PET studies in human subjects. Logan, J. (Brookhaven National Laboratory, Upton, NY (USA)); Fowler, J.S.; Volkow, N.D.; Wolf, A.P.; Dewey, S.L.; Schlyer, D.J.; MacGregor, R.R.; Hitzemann, R.; Bendriem, B.; Gatley, S.J. *Journal of Cerebral Blood Flow and Metabolism (USA),* 10(5): 740-747 (Sep 1990).

A graphical method of analysis applicable to ligands that bind reversibly to receptors or enzymes requiring the simultaneous measurement of plasma and tissue radioactivities for multiple times after the injection of a radiolabeled tracer is presented. It is shown that there is a time t after which a plot of integral of t0ROI(t')dt'/ROI(t) versus integral of t0Cp(t')dt'/ROI(t) (where ROI and Cp are functions of time describing the variation of tissue radioactivity and plasma radioactivity, respectively) is linear with a slope that corresponds to the steady-state space of the ligand plus the plasma volume,.Vp. For a two-compartment model, the slope is given by lambda + Vp, where lambda is the partition coefficient and the intercept is -1/[kappa 2(1 + Vp/lambda)]. For a three-compartment model, the slope is lambda(1 + Bmax/Kd) + Vp and the intercept is -(1 + Bmax/Kd)/k2 + [koff(1 + Kd/Bmax)]-1 [1 + Vp/lambda(1 + Bmax/Kd)]-1 (where Bmax represents the concentration of ligand binding sites and Kd the equilibrium dissociation constant of the ligand-binding site complex, koff (k4) the ligand-binding site dissociation constant, and k2 is the transfer constant from tissue to plasma). This graphical method provides the ratio Bmax/Kd from the slope for comparison with in vitro measures of the same parameter. It also provides an easy, rapid method for comparison of the reproducibility of repeated measures in a single subject, for longitudinal or drug intervention protocols, or for comparing experimental results between subjects. Although the linearity of this plot holds when ROI/Cp is constant, it can be shown that, for many systems, linearity is effectively reached some time before this. This analysis has been applied to data from [N-methyl-11C]-(-)-cocaine studies in normal human volunteers and the results are compared to the standard nonlinear least-squares analysis.

51830 Biosynthesis of the manumycin group antibiotics. Thiericke, R. (Universitaet Goettingen (West Germany)); Zeeck, A.; Nakagawa, Akira; Omura, Satoshi; Herrold, R.E.; Wu, S.T.S.; Beale, J.M.; Floss, H.G. *Journal of the American Chemical Society (USA),* 112(10): 3979-3987 (9 May 1990).

The biosynthesis of the manumycin group antibiotics manumycin (1) and asukamycin (2) was studied in Streptomyces parvulus Tue 64 and Streptomyces nodosus ssp. asukaensis ATCC 29,757 by using radioactive and stable isotope tracer techniques and high-field NMR spectroscopy. The results have demonstrated that the central, multifunctional mC_7N unit typical of this group of antibiotics, which serves as the starter unit for a short polyketide chain, is biosynthesized from a C_4 Krebs cycle and a C_3 triose phosphate pool intermediate by a new pathway, distinct from the shikimate, polyketide, or pentose phosphate routes leading to other mC_7N units in nature. The C_5 unit in both 1 and 2 arises by a novel intramolecular cyclization of 5-aminolevulinic acid, and a cyclohexane ring and the adjacent carbon in 2 arise from the seven carbon atoms of shikimic acid. The side chains of both antibiotics represent typical polyketide-derived moieties, differing with respect to their combinations of starter and elongation units.

51831 Technetium(V) and rhenium(V) complexes of 2,3-bis(mercaptoacetamido)propanoate. Chelate ring stereochemsitry and influence on chemical and biological properties. Rao, T.N. (NeoRx Corp., Seattle, WA (USA)); Adhikesavalu, D.; Camerman, A.; Fritzberg, A.R. *Journal of the American Chemical Society (USA),* 112(15): 5798-5804 (18 Jul 1990). DOE Contract AC02-83ER60140.

Monoxo complexes of technetium(V) and rhenium(V) with 2,3-bis(mercaptoacetamido)propanoate (map) have been synthesized. The complexes with general formula $[Ph_4X][MO(map)]$ (where X = As, P; M = Tc, Re) were characterized by IR, visible-UV spectra, and negative ion fast atom bombardment spectroscopy. The chelate ring epimers were separated by HPLC (semipreparative reverse-phase C_{18}) isolated and crystallized as salts of $[Ph_4X][MO(map)]$. The structures of the two epimers (syn and anti) of technetium and one of the epimers (syn) of the rhenium complexes were determined by single-crystal X-ray analyses. All three complexes crystallize in the space group $P2_1/c$ and have four formula units in the unit cell. In all of the three complexes, the metal (Tc, Re) is coordinated to one oxygen (yl) atom, two sulfur (thiolate) atoms, and two nitrogen atoms (amide) in a distorted square-pyramidal geometry. The position trans to the oxygen (yl) atom is vacant.

51832 Radiohalogenated thienylethylamine derivatives for evaluating local cerebral blood flow. Goodman, M.M.; Knapp, F.F. Jr. To Dept. of Energy, Washington, DC (USA). USA Patent 4,900,539/A/. 13 Feb 1990. Filed date 22 Dec 1988. USA Patent patents application 7-288,349. Int. Cl. A61K 49/02. 4p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes radiopharmaceuticals useful in brain imaging. They comprise radiohalogenated thienylethylamine derivatives. The compounds are 5-halo-thiophene-2-isopropyl amines able to cross the blood-brain barrier and be retained for a sufficient length of time to allow the evaluation or regional blood flow by radioimaging of the brain.

51833 Method for nuclear magnetic resonance imaging using deuterum as a contrast agent. Kehayias, J.J.; Joel, D.D.; Adams, W.H.; Stein, H.L. To Dept. of Energy, Washington, DC (USA). USA Patent 4,893,627/A/. 16 Jan 1990. Filed date 26 May 1988. USA Patent patents application 7-200,811. Int. Cl. A61B 5/05. 4p. Source: Patent and Trademark Office, Box 9, Washington, DC 20232 (USA).

This patent describes a method for in vivo NMR imaging of the blood vessels and organs of a patient characterized by using a dark dye-like imaging substance consisting essentially of a stable, high-purity concentration of D_2O in a solution with water.

5507 Microbiology

Refer also to citation(s) 50264, 50268, 50271, 50280, 50281, 50283, 50284, 50286, 50666

51834 Development of avian sarcoma and leukosis virus-based vector-packaging cell lines. Stoker, A.W. (Univ. of California, Berkeley (USA)); Bissell, M.J. *Journal of Virology (USA),* 62(3): 1008-1015 (Mar 1988). DOE Contract AC03-76SF00098.

The authors have constructed an avian leukosis virus derivative with a 5′ deletion extending from within the tRNA primer binding site to a SacI site in the leader region. The aim was to remove cis-acting replicative and/or encapsidation sequences and to use this derivative, RAV-1Ψ^-, to develop vector-packaging cell lines. They show that RAV-1Ψ^- can be stably expressed in the quail cell line QT6 and chicken embryo fibroblasts and that it is completely replication deficient in both cell types. Moreover, they have demonstrated that QT6-derived lines expressing RAV-1Ψ^- can efficiently package four structurally different replication-defective v-src expression vectors into infectious virus, with very low or undetectable helper virus release. These RAV-Ψ^--expressing cell lines comprise the first prototype avian sarcoma and leukosis virus-based vector-packaging system. The construction of our vectors has also shown us that a sequence present within gag, thought to facilitate virus packaging, is not necessary for efficient vector expression and high virus production. They show that quantitation and characterization of replication-defective viruses can be achieved with a sensitive immunocytochemical procedure, presenting an alternative to internal selectable vector markers.

51835 Identification of the gene coding for the precursor of adenovirus core protein X. Weber, J.M. (Universite de Sherbrooke, Quebec (Canada)); Anderson, C.W. *Journal of Virology (USA),* 62(5): 1741-1745 (May 1988).

Nucleoprotein complexes extracted from infected cells or ts1 virions grown at 39°C contain, in addition to known virion proteins, a polypeptide with a molecular weight of 11,000 (11K polypeptide). The authors identified the gene for this polypeptide by sequence analysis of the radioactively labeled 11K polypeptide isolated from ts1 virions and comparison of this sequence with the nucleotide sequence of the adenovirus type 2 genome. The 11K polypeptide was encoded by an open reading frame of 80 residues located between nucleotides 17,676 and 17,915 in late transcription region 2

of adenvirus type 2; the initiating methionine residue was removed leaving a 79-residue product. The late transcription region 2 that encoded the 79-residue polypeptide (11K) was arginine rich (21%) and had a predicted molecular weight of 8,715. It was cleaved by the viral endoprotease to give two products which comigrated on sodium dodecyl sulfate-polyacrylamide gels as virion polypeptide X. The data suggest that additional cleavage of the carboxy-terminal 48-residue fragment generates a 19-amino-acid fragment with the amino acid composition of mu.

5508 Morphology

Refer also to citation(s) 51794

5509 Pathology

Refer also to citation(s) 51793, 51794

51836 (AD-A-223638/8/XAB) **Pathophysiology and toxicokinetic studies of blue-green algae intoxication in the swine model. Annual report, 1 September 1987-31 August 1988.** Beasley, V.R.; Haschek-Hock, W.M.; Carmichael, W.W.; Cook, W.O.; Dahlem, A.M. Illinois Univ., Urbana, IL (USA). 26 Sep 1989. 160p. Contract DAMD17-85-C-5241. Source: NTIS, PC A08/MF A01.

An attempt by New England Nuclear to produce radiolabelled MCLR involved synthetic labelling using tritiated water and Rh/Al_2O_3. Chromatography and mass spectrometry revealed radiolabel incorporation into both the toxin and contaminants. The nonspecifically tritiated toxin had a specific activity of 05 uCi/mg. Subsequently, a method recommended by our laboratory utilizing tritiated water with pyridine was performed by New England Nuclear; however, decomposition of the toxin occurred under the conditions used. MCLR was highly bound when added to superactivated charcoal at 1:100. When given to rats via an ileal loop shortly after toxin administration, superchar settled out, but was partially effective in limiting MCLR absorption (as indicated by increases in liver weight).

51837 (DOE/BP/35585–3) **Augmented fish health monitoring: Annual report.** Warren, J.W. Fish and Wildlife Service, Portland, OR (USA). 15 Aug 1990. 132p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract AI79-87BP35585. Order Number DE91000757. Source: NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Augmented Fish Health Monitoring Contract AI79-87BP35585 was implemented on July 20, 1987. This report briefly describes third-year work being done to meet contract requirements for fish disease surveillance at Service facilities in the Columbia River basin and for histopathological support services provided to participating state agencies. It also summarizes the health status of fish reared at participating Service hatcheries and provides a summary of case history data for calendar year 1989. Items of note included severe disease losses to infectious hematopoietic necrosis (IHN) in summer steelhead trout in Idaho, the detection of IHN virus in juvenile spring chinook salmon at hatcheries on the lower Columbia River, and improved bacterial kidney disease (BKD) detection and adult assay by enzyme-linked immunosorbent assay (ELISA) technology at the Dworshak Fish Health Center. Complete diagnostic and inspection services were provided to 13 Columbia River Basin National Fish Hatcheries. Case history data was fully documented in a computerized data base for storage and analysis and is summarized herein. 2 refs., 1 fig., 4 tabs.

5510 Physiological Systems

Refer also to citation(s) 51774

51838 **Root versus shoot biomass: Responses to water, nitrogen, and phosphorus applications for Agave lechuguilla.** Nobel, P.S. (Univ. of California, Los Angeles (USA)); Quero, E.; Linares, H. *Botanical Gazette (Chicago) (USA),* 150(4): 411-416 (Dec 1989). DOE Contract FC03-87ER60615.

Shoot and root growth of Agave lechuguilla, a Crassulacean acid metabolism (CAM) succulent widespread in the Chihuahuan Desert, was examined under natural conditions and with two watering regimes, five treatments involving N application to the soil surface, and three treatments involving P application. Under natural conditions root of A. lechuguilla made up only 3.7% of the total plant dry weight, suggesting that this species may be especially sensitive to changes in soil resources. Over the 2-yr study period, increasing the availability of soil water by weekly irrigation increased shoot dry weight of A. lechuguilla by 40% and root dry weight by 75%, which represented a doubling of the increment in plant growth compared with control plants receiving only rainfall. This doubling is consistent with changes in the Water Index (a relative measure of net CO_2 uptake that has a maximum value of unity under wet conditions), which was predicted to be twice as large for the irrigated condition. The greater enhancement of root compared with shoot growth caused by increased water availability should lead to slightly more water uptake, which can compensate for the slightly greater reliance on daytime CO_2 uptake by A. lechuguilla under wet conditions. The leaf N level tended to rise with the application level of N, the increase being 15% at 500 kg N ha^{-1}, whereas the leaf P level was little affected by P applications up to 500 kg ha^{-1}. Application of 100 kg N ha^{-1} increased shoot dry weight by 51% over the 2-yr study period with no effect on root dry weight, and application of 500 kg P ha^{-1} increased shoot dry weight by 40% but decreased root dry weight by 37%. At these application levels, which were optimal for shoot growth, the roots of A. lechuguilla made up only about 2% of the total plant dry weight.

5520 Public Health

Refer also to citation(s) 51697

5530 Agriculture and Food Technology

Refer also to citation(s) 50700, 50877

51839 (DOE/CE/15270–T15) **Explorations of mechanisms regulating ectomycorrhizal colonization of boron-fertilized pine: Quarterly report, October 1, 1990–December 31, 1990.** Garrett, H.E.; Sword, M.A. Missouri Univ., Columbia, MO (USA). [1990]. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-86CE15270. Order Number DE91000032. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This progress report discusses activities for the period 10/1/90–12/31/90. Continued data analysis and interpretation have been delayed; but will resume as time permits. Foliar cytokinin and mineral nutrient analyses will be performed following identification of satisfactory analytical procedures. Caffeic acid was chosen as a model phenolic compound for complex identification trials. Fluorometric methods were used for observation of the effect of boric acid on caffeic acid. High performance liquid chromatographic techniques have been initiated for further identification of the potential boric acid-caffeic acid complex. A greenhouse experiment has been installed for evaluation of the biological effects of boric acid on shortleaf pine seedlings. 5 figs., 3 tabs.

51840 (HCR-CDTN–13) **Use of progesterone radioimmunoassay techniques for improving reproduction performances in dary catties.** Benyoucef, M.T. (Haut Commissariat a la Recherche, Algiers (Algeria)); Benabdelaziz, A.; Khelili, R. Haut Commissariat a la Recherche, Algiers (Algeria). Centre de Developpement des Techniques Nucleaires. Jul 1990. 18p. (In French). Order Number DE91604236. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report deals with the first measurements of progesterone, by radioimmunoassay (P4-PIA) in blood samples, to assess fertility in livestock (cattle) in Algeria, by improvement of the level of reproduction management. For this purpose, the results obtained throughout first analysis of P4 on a sample of 15 bovines females, composed by 12 heifers and 3 cows confirm the efficiency of the techniques in improving dary cattle reproduction performances. Ovarian activity can be determined for cows at the moment of post partum and for heifers before breeding as well as, pregnancy confirmation on breeding heifers. It is interesting to extend the experiments using these techniques to a higher number of livestocks

(breeds and species) and to develop new research subjects in this field.

51841 (ORNL/Sub–86-91324/1) **Improving rapeseed production practices in the southeastern United States: Final project report.** Thomas, D.L. (Georgia Univ., Tifton, GA (USA). Georgia Coastal Plain Experiment Station); Breve, M.A.; Raymer, P.L.; Minton, N.A.; Sumner, D.R. Oak Ridge National Lab., TN (USA); Georgia Univ., Tifton, GA (USA). Georgia Coastal Plain Experiment Station. Apr 1990. 42p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90017900. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Oilseed rape or rapeseed is a crop which offers a potential for double-cropping in the southeastern United States. This final project report describes the results from a three year study aimed at evaluating the effect of different planting and harvesting practices on establishment and yield of three rape cultivars, and the double cropping potential of rapeseed in the southeastern United States. The project was conducted on two yield sites in Tifton, Georgia during 1986–87, 1987–88 and 1988–89. The general objective of this research is to improve the seed and biomass yield of winter rapeseed in the southeastern United States by developing appropriate agronomic practices for the region. The primary constraint is to grow rapeseed within the allowable period for double cropping with an economically desirable crop, such as peanut or soybean. Planting and harvesting are the most critical steps in this process. Therefore, the specific objectives of this research were: evaluate and improve the emergence of rapeseed by developing planting techniques that enhance the soil, water and seed regimes for winter rapeseed in the southeast, and evaluate and improve the yields of harvested rapeseed by developing techniques for determining the optimum timing of harvest and efficient methods for harvesting winter rapeseed in the southeast. 6 refs., 12 figs., 9 tabs.

51842 (RERF-TR–3-90) **An improved method for detecting genetic variation in DNA using denaturing gradient gel electrophoresis.** Takahashi, Norio; Hiyama, Keiko; Kodaira, Mieko; Satoh, Chiyoko. Radiation Effects Research Foundation, Hiroshima (Japan). May 1990. 18p. Order Number DE91712969. Source: NTIS (US Sales Only), PC A03/MF A01.

We have examined the feasibility of denaturing gradient gel electrophoresis (DGGE) of RNA:DNA duplexes to detect variations in genomic and cloned DNAs. The result has demonstrated that use of RNA:DNA duplexes makes DGGE much more practical for screening a large number of samples than use of DNA:DNA heteroduplexes, because preparation of RNA probes is easier than that of DNA probes. Three different ^{32}P-labeled RNA probes were produced. Genomic or cloned DNAs were digested with restriction enzymes and hybridized to labeled RNA probes, and resulting RNA:DNA duplexes were examined by DGGE. The presence of a mismatch(es) was detected as a difference in the mobility of bands on the gel. The experimental conditions were determined using DNA segments from cloned normal and three thalassemic human β-globin genes. The results from experiments on the cloned DNAs suggest that DGGE of RNA:DNA duplexes will detect nucleotide substitutions and deletions in DNA. In the course of these studies, a polymorphism due to a single-base substitution at position 666 of IVS2 (IVS2-666) of the human β-globin gene was directly identified using genomic DNA samples. A study of 59 unrelated Japanese from Hiroshima was undertaken in which the frequency of the allele with C at IVS2-666 was 0.48 and that of the allele with T was 0.52. This approach was found to be very effective for detecting heritable variation and should be a powerful tool for detecting fresh mutations in DNA, which occur outside the known restriction sites. (author).

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 50877, 51697, 51952, 52237, 52265, 52267

51843 (CONF-9006220–4) **Protection by WR-2721 and WR-151327 against late effects of gamma rays and neutrons.** Grdina, D.J.; Carnes, B.A.; Nagy, B. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 28. COSPAR plenary conference; The Hague (Netherlands); 25 Jun - 6 jul 1990. Order Number DE90017792. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two thiophosphoroate compounds WR-2721 and WR-151327 were assessed for their ability to modify the deleterious effects (life shortening and carcinogenesis) of fission-spectrum neutrons or gamma rays on B6CF1 hybrid mice. Male and female mice were irradiated individually at 110 days of age. Radioprotectors were administered intraperitoneally 30 min prior to irradiation. Animals were housed five to a cage; cage locations in the holding rooms were randomized by computer. Animals were checked daily and all deceased animals were necropsied. WR-2721 afforded protection against both neutron- and gamma-ray-induced carcinogenesis and subsequent life shortening. Cumulative survival curves for unirradiated mice of either sex were unaffected by protectors. 28 refs., 6 figs.

51844 (CRIE-U–89041) **Development of technology for plantlet propagation by tissue culture. 1.: Effect of plant hormones on strawberry callus formation and their regeneration.** Yoshihara, T.; Hanyu, H. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1989. 30p. (In Japanese). Order Number DE91701406. Source: NTIS (US Sales Only), PC A03/MF A01.

For mass propagation of strawberry seedlings via callus by liquid culture method with a higher cultural efficiency, it is required to form calluses which are dispersed homogeneously in liquid culture and are easy to isolate to individual. Then an investigation on the effect of plant hormones on callus formation was conducted. Sorts and concentrations of plant hormones, regeneration ratio from the callus, and the frequency of morphological mutations of the plantlets were examined. Auxins; 2,4-dichlorophenoxy acetic acid (2,4-D) and two others, and cytokinins; kinetin (KIN) and two others were used for plant hormones. These hormones were tested in serial concentrations between 0 to 5 ppm and in combinations with each auxins and cytokinins. Cytokinins were better to form and grow the callus in the vicinity of 0.2ppm, and auxins gave the highest growth rate of callus at 0.5 to 2 ppm. It was concluded that optimizing condition for the callus formation was KIN 0.1-0.5 ppm and 2,4-D 0.1-1ppm. 18 refs., 15 figs., 3 tabs.

51845 (HSE-Trans–13472A) **Hot springs and measures to counter harmful components.** Ishii, T. (Taisei Construction Co. Ltd., Tokyo (Japan)). Health and Safety Executive, London (UK). Nov 1989. 9p. Translated from Safety Engineering, no. 64 (Sep 1989) v. 16(2). Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Safety Engineering, no. 64 (Sep 1989) v. 16(2).

A translation is given of a Japanese article on hot springs for medical uses. Topics covered include the nature of the hot springs, how the springs are formed, the medical applications, the harmful components in hot springs and countermeasures. (UK).

51846 (HSE-Trans–13528A) **Toxicology - study of the intracellular localization of beryllium by analytical ion microscopy.** Berry, J-P. (Paris-12 Univ., 94 - Creteil (France)); Escaig, F.; Galle, P. Health and Safety Executive, London (UK). Nov 1989. 9p. Translated from C. R. Acad. Sci., Ser. 3 (1987) v. 304(10) p. 239-243. Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from C. R. Acad. Sci., Ser. 3 (1987) v. 304(10) p. 239-243.

The intracellular distribution of a beryllium salt in the kidneys of rats was studied by analytical ion microscopy. Beryllium has a special affinity for certain regions of the cellular nuclei where heavy concentrations appear. Examining these same nuclei under an electron microscope enables attention to be drawn to very unusual ultrastructural abnormalities in these same nuclear regions. These observations are to be seen in the light of this element's highly carcinogenic action. (author).

51847 (HSE-Trans–13534A) **Influence of beryllium chloride and oxide on the sexual function in female rats and development of offspring.** Selivanova, L.N.; Savinova, T.B. Health and Safety Executive, London (UK). Nov 1989. 6p. Translated from Gigiena i sanitariya (1986) v. 8 p. 44-46. Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Gigiena i sanitariya (1986) v. 8 p. 44-46.

A translation is given of a Russian article on the influence of beryllium chloride and oxide on the sexual cycle in female rats and on their capacity to conceive; another aim was to identify any embryotoxic and teratogenic effect of these compounds and to identify the exposure period values for pregnant females and the capacity of beryllium to penetrate the placenta and to accumulate in the foetus. (UK).

51848 (HSE-Trans–13538A) **Contractility of the myocardium in chronic berylliosis sufferers based on electrokymography data.** Mekhtieva, D.M. (Academy of Medical Sciences of the USSR (USSR). Inst. of Hygiene at Work and Occupational Diseases). Health and Safety Executive, London (UK). Nov 1989. 5p. Translated from Gigiena truda i professional'nye zabolevaniya (1974) v. 18(11) p. 24-26. Source: Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Gigiena truda i professional'nye zabolevaniya (1974) v. 18(11) p. 24-26.

A translation of a Russian article is given on the contractility of the myocardium in 40 chronic berylliosis sufferers based on electrokymography data. Indicators of the contractility of the myocardium studies included the isometric contraction phase, the stress period, the expulsion period, the mechanical systole, Karpman's intrasystolic indicator and Blumberger's mechanical coefficient. Ilasmodynamic indices of the circulation studied included the stroke and minute volume of the heart, and the rate of increase in intraventricular pressure. (UK).

51849 (HSE-Trans–13540A) **Toxic properties of some soluble beryllium compounds (data from experimental morphological studies).** Litvinov, N.N.; Bugryshev, P.V.; Kazenashev, V.F. Health and Safety Executive, London (UK). Dec 1989. 6p. Translated from Gigiena truda i professional'nye zabolevaniya (1975) v. 19(7) p. 34-37. Source: Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translated from Gigiena truda i professional'nye zabolevaniya (1975) v. 19(7) p. 34-37.

The toxic properties of beryllium chlorides and beryllium fluorides were studied by exposing white, female rats to intoxication by inhalation over a period of 4 months. Histological studies of lung tissue revealed pneumosclerosis, nodules and lung tumours developing after inhalation of beryllium compounds at concentrations of 0.04 and 0.02 Be^{2+}/m^3. (UK).

51850 (LBL–27660, pp. 85-88) **Possible involvement of radiation damage in soft x-ray microscopy of mammalian cells.** Shinohara, Kunio (Tokyo Metropolitan Institute of Medical Science, Tokyo (Japan)); Ito, Atsushi. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

When specimens are observed by soft x-ray microscopy, they always absorb many photons leading to the radiation damage of them. In most cases, estimated absorbed doses are not smaller that 10^4 Gy (1 Gy = 100 rad). It is, therefore, of interest to study the probable effects of radiation on mammalian cells when they absorbed 10^4 Gy. In conclusion, (1) radiation effects on the cells irradiated with 10^4 Gy of 1.5 keV x-rays were estimated for the induction of structural changes in relation to the chromosome structure in mammalian cells; (2) time scale for the structural change may be slower than the achievable time for x-ray microscopy; (3) short pulse (less than msec) exposure is recommended for the observation of chromosome fiber in hydrated mammalian cells by x-ray microscopy (the time may depend on the size of the molecule to be observed); and (4) x-ray microscopy will be the most accessible instrument to reveal the time sequence of the radiation effect on the structural change.

51851 (LBL–27660, pp. 89-102) **Limitations to significant information in microscopy of biological macromolecules as a consequence of radiation damage.** Glaeser, R.M. (Univ. of California, Berkeley (USA)). Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

All types of currently useful short-wavelength radiation represent a flux of ionizing radiation as well as a wave-field that is suitable for diffraction and/or imaging. Obviously, then, there must ultimately be some physical limitation associated with their use for microscopy. The question is to define what the limitations should be. A self evident limitation will occur if the exposure which one uses to record an image is above a certain critical value (N_{cr} quanta per unit area) at which the biochemical function or even the detailed structure of the macromolecule has been destroyed. Under these conditions one might still produce some kind if an image, but the information contained in the image will no longer be significant. A second limitation enters into the story if the exposure is kept below this critical exposure. For any finite exposure there will be a precisely determined amount of statistical variation in the number of quanta per picture element. This shot noise becomes more and more sever as the pixel size decreases, i.e. as the resolution increases. Thus, very small features and/or very low contrast features can no longer be reliably detected, if images are taken with exposures less than the critical dose, and if that critical dose is too low.

51852 (LBL–27660, pp. 108-113) **DNA base pair sequencer: Scanning tunneling microscope plus infrared radiation.** Dawson, J. (Univ. of California, Los Angeles (USA)); Sessler, A. Lawrence Berkeley Lab., CA (USA). Aug 1989. (CONF-8905192–: Conference on X-ray microimaging for the life sciences, Berkeley, CA (USA), 24-26 May 1989). In *X-ray microimaging for the life sciences.* 206p. Order Number DE90002613. Source: NTIS, PC A10/MF A01.

There is a large amount of effort going into the sequencing of the base pairs on the human genome. We propose that a combination of Scanning Tunneling Microscopy (STM) and Infrared Excitation (IRE) of the different base pairs may be able to do the sequencing. Such a method could be rapid, accurate, and nondestructive to the molecule. The scanning tunneling microscope has the required resolution while an infrared laser provides selective excitation of each of the four base pairs. The combination provides identification of a particular base. If this proves to be a feasible sequencing method it would be much cheaper, easier, and faster. The STM moves at a rate of (about) 1000 Å/sec and hence one instrument can sequence at a rate of 30 base pairs per second. The method proposed has application far beyond DNA sequencing and thus should prove useful, if established, in many different fields of science. The radiation need not be in the infrared; energy can be transferred from electronic excitation into vibrational modes or if electronic excitations remain localized sufficiently well they might produce image discrimination.

51853 (NUREG–1396) **Environmental assessment of the thermal neutron activation explosive detection system for concourse use at US airports.** Jones, C.G. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Industrial and Medical Nuclear Safety. Aug 1990. 152p. Sponsored by Nuclear Regulatory Commission. Source: NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

This document is an environmental assessment of a system designed to detect the presence of explosives in checked airline baggage or cargo. The system is meant to be installed at the concourse or lobby ticketing areas of US commercial airports and uses a sealed radioactive source of californium-252 to irradiate baggage items. The major impact of the use of this system arises from direct exposure of the public to scattered or leakage radiation from the source and to induced radioactivity in baggage items. Under normal operation and the most likely accident scenarios, the environmental impacts that would be created by the proposed licensing action would not be significant. 44 refs., 19 figs., 18 tabs.

51854 (PB–90-262114/XAB) **Transuranium elements. Volume 1. Elements of radiation protection.** Burley, G. Office of Radiation Programs, Washington, DC (USA). Jun 1990. 169p. (EPA–520/1-90/015). Source: NTIS, PC A08/MF A01.

See also Volume 2, PB–90-262122.

The report consists of two volumes and addresses the problem of environmental contamination by plutonium and other transuranium elements. Volume 1 presents an overview of selected information on the chemical and physical properties of the transuranium elements, the biological effects and risks of exposure, the major environmental transport mechanisms, and the contamination in the environs of a number of sites in the United States.

51855 (PNL–7277) **Performance testing of extremity dosimeters against a draft standard.** Harty, R.; Reece, W.D.; Hooker, C.D.; McDonald, J.C. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 60p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE91000052. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The assurance of worker radiation safety is directly related to the performance of personnel dosimetry. The US Department of Energy (DOE) has long recognized this critical relationship and has addressed this issue by instituting the DOE Laboratory Accreditation Program (DOELAP) which strives to improve the quality of personnel dosimetry through performance testing, dosimetry calibration, intercomparisons, evaluations and accreditations. One area of personnel dosimetry that has not been specifically addressed by DOELAP is extremity dosimeter testing. This task was directed at assessing the problems of implementing extremity dosimeter performance testing. A series of performance tests were made based on a draft standard written by the Health Physics Society Standards Committee (HPSSC) using extremity dosimeters currently in use at DOE and DOE contractor facilities. The results of this study indicate the need to incorporate performance testing of extremity dosimetry systems into DOELAP. Based on the results of this study, recommendations are made for improvements to the draft standard. 20 refs., 6 figs., 3 tabs.

51856 (PNL–7439) **A study of detailed dosimetry records for a selected group of workers included in the Hanford mortality study.** Gilbert, E.S. Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 44p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE91000064. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Detailed dosimetry data from microfiche and microfilm in source records for the years 1944–1978 for 139 Hanford workers were examined. Information on these records was compared with computerized dose equivalent estimates used in mortality analyses. Because of difficulties in reading some early source records, and because of variation in the format of records and in algorithms for calculating whole body dose, this validation was difficult. However, apparent discrepancies in cumulative dose were less than 0.1 rem for 88% of the workers in this study, never exceeded 1.5 rem, and would be unlikely to distort conclusions of dose-response analyses. Most discrepancies occurred in early years of Hanford operations, especially 1944–46, with very few problems with dose estimates from the 1960's and 1970's. The study also provided data dosimetry practices, by calendar year, on frequency of monitoring, the number and proportion of dosimeters yielding positive results, and the magnitude of doses recorded for individual dosimeters. 7 refs., 5 figs., 13 tabs.

51857 (RERF-TR–10-87) **Search for mutations altering protein charge and/or function in children of atomic bomb survivors: final report.** Neel, J.V.; Satoh, Chiyoko; Goriki, Kazuaki; Asakawa, Jun-ichi; Fujita, Mikio; Takahashi, Norio; Kageoka, Takeshi; Hazama, Ryuji. Radiation Effects Research Foundation, Hiroshima (Japan). Apr 1990. 22p. Order Number DE91712967. Source: NTIS (US Sales Only), PC A03/MF A01.

A sample of children whose parents were proximally exposed at the time of the atomic bombings of Hiroshima and Nagasaki (i.e., within 2,000 m of the hypocenter) and a suitable comparison group have been examined for the occurrence of mutations altering the electrophoretic mobility or activity of a series of 30 proteins. The examination of the equivalent of 667,404 locus products in the children of proximally exposed persons yielded three mutations altering electrophoretic mobility; the corresponding figure for the comparison group was three mutations in 466,881 tests. The examination of a subset of 60,529 locus products for loss of enzyme activity in the children of proximally exposed persons yielded one mutation; no mutations were encountered in 61,741 determinations on the children of the comparison group. Combining these two series, the mutation rate observed in the children of proximally exposed is thus 0.60×10^{-5}/locus/generation, with 95% confidence intervals between 0.2 and 1.5×10^{-5}, and in the comparison children, 0.64×10^{-5}/locus/generation, with 95% intervals between 0.1 and 1.9×10^{-5}. The average conjoint gonad doses of the proximally exposed parents are estimated to be 0.437 Gy of gamma radiation and 0.002 Gy of neutron radiation. Assigning a relative biological effectiveness of 20 to the neutron radiation, the combined total gonad dose of the parents becomes 0.477 Sv. (author).

51858 (RERF-TR–22-89) **Spontaneous loss and alteration of antigen receptor expression in mature CD4+ T cells.** Kyoizumi, Seishi; Akiyama, Mitoshi; Hirai, Yuko; Kusunoki; Yoichiro; Tanabe, Kazumi; Umeki, Shigeko; Nakamura, Nori; Yamakido, Michio; Hamamoto, Kazuko. Radiation Effects Research Foundation, Hiroshima (Japan). Apr 1990. 25p. Order Number DE91712966. Source: NTIS (US Sales Only), PC A03/MF A01.

The T-cell receptor CD3 (TCR/CD3) complex plays a central role in antigen recognition and activation of mature T cells, and therefore abnormalities in the expression of the complex should induce unresponsiveness of T cells to antigen stimulus. Using flow cytometry, we detected and enumerated variant cells with loss or alteration of surface TCR/CD3 expression among human mature CD4+ T cells. The presence of variant CD4+ T cells was demonstrated by isolating and cloning them from peripheral blood, and their abnormalities can be accounted for by alterations in TCR expression such as defects of protein expression and partial protein deletion. The variant frequency in peripheral blood increased with aging in normal donors and was highly elevated in patients with ataxia telangiectasia, an autosomal recessive inherited disease with defective DNA repair and variable T-cell immunodeficiency. These findings suggest that such alterations in TCR expression are induced by somatic mutagenesis of TCR genes and can be important factors related to age-dependent and genetic disease-associated T-cell dysfunction. (author).

51859 Poisson regression analysis of the mortality among a cohort of World War II nuclear industry workers. Frome, E.L. (Oak Ridge National Laboratory, TN (USA)); Cragle, D.L.; McLain, R.W. *Radiation Research (USA)*, 123(2): 138-152 (Aug 1990).

A historical cohort mortality study was conducted among 28,008 white male employees who had worked for at least 1 month in Oak Ridge, Tennessee, during World War II. The workers were employed at two plants that were producing enriched uranium and a research and development laboratory. Vital status was ascertained through 1980 for 98.1% of the cohort members and death certificates were obtained for 96.8% of the 11,671 decedents. A modified version of the traditional standardized mortality ratio (SMR) analysis was used to compare the cause-specific mortality experience of the World War II workers with the U.S. white male population. An SMR and a trend statistic were computed for each cause-of-death category for the 30-year interval from 1950 to 1980. The SMR for all causes was 1.11, and there was a significant upward trend of 0.74% per year. The excess mortality was primarily due to lung cancer and diseases of the respiratory system. Poisson regression methods were used to evaluate the influence of duration of employment, facility of employment, socioeconomic status, birth year, period of follow-up, and radiation exposure on cause-specific mortality. Maximum likelihood estimates of the parameters in a main-effects model were obtained to describe the joint effects of these six factors on cause-specific mortality of the World War II workers. We show that these multivariate regression techniques provide a useful extension of conventional SMR analysis and illustrate their effective use in a large occupational cohort study.

51860 3-Aminobenzamide, an inhibitor of poly(ADP-ribose) polymerase, is a stimulator, not an inhibitor, of DNA repair. Cleaver, J.E. (Univ. of California, San Francisco (USA)); Morgan,

W.F. *Experimental Cell Research (USA)*, 172(2): 258-264 (Oct 1987).

An inhibitor of poly(ADP-ribose) synthesis, 3-aminobenzamide (3AB), at low concentrations was found to reduce strand-break frequencies and increase repair replication in human lymphoid cells damaged by methyl methanoesulfonate. A concentration of 0.1 mM 3AB was adequate to produce a maximum effect on strand-break frequencies and repair replication. This evidence, together with previous measurements, demonstrates that 3AB cannot be regarded as an inhibitor of DNA repair; rather, it actually accelerates the ligation of DNA repair patches. Previous considerations of 3AB as a repair inhibitor may have derived from the use of excessive concentrations above 1 mM that may have stimulated additional damage and from the use of ethyl alcohol as a solvent for 3AB. Interpretations of the role of single-strand breaks and poly(ADP-ribose) in DNA repair, differentiation, and gene activity may need reevaluation because they have frequently been based on an erroneous notion of 3AB as a repair inhibitor, when its mode of action is, in fact, more complex.

51861 **Differential effect of ionizing radiation on transcription in repair-deficient and repair-proficient mice.** Munson, G.P. (Argonne National Laboratory, IL (USA)); Woloschak, G.E. *Cancer Research (USA)*, 50(16): 5045-5048 (15 Aug 1990).

Experiments were designed to examine in vivo changes in total transcription and in the expression of the c-fos gene following whole-body exposure of mice to JANUS fission-spectrum neutrons. Radiation repair-deficient (wst/wst) and -proficient (wst/., C57BL/6 x C3H F1) mice were exposed to JANUS fission-spectrum neutrons calibrated to deliver a gut dose of 50 cGy. Animals were sacrificed less than 10 or at 60 min postirradiation, and gut tissues were removed for study. Our results revealed that, in repair-proficient mice, an immediate depression (relative to untreated control) in total transcription was evident that continued through 1 h postirradiation. Conversely, radiation-sensitive wst/wst mice displayed doubled transcription levels postirradiation. Expression of c-fos was consistently depressed following radiation exposure in control and wst/wst mice. However, the depression of c-fos mRNA was delayed in wst/wst mice relative to controls. These results demonstrate abnormal regulation of transcription and of c-fos mRNA accumulation in repair-deficient wasted mice following exposure to ionizing radiation. In addition, this work documents rapid total transcriptional depression in normal mice following radiation exposure.

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Refer also to citation(s) 50489, 50743, 50937, 51639, 51652, 51658, 51711, 51746, 51754, 51755, 51756, 51761, 51778, 51845

51862 (AD-A-223526/5/XAB) **Determination of the repeated oral toxicity of halocarbon oil, series 27-S.** Kinkead, E.R.; Culpepper, B.T.; Henry, S.S.; Szotak, P.S.; Flemming, C.D. Naval Medical Research Inst., Bethesda, MD (USA). 1990. 17p. (NMRI-90-44). Source: NTIS, PC A03/MF A01.

Pub. Toxicology and Industrial Health, Vol. 6, No. 1, 17-32(1990).

Halocarbon 27-S (HC 27-S), a polymer of chlorotrifluoroethylene (CTFE), is used as a lubricating oil for pumps in hyperbaric chambers. Although monomeric CTFE has been shown to produce renal lesions in rats, the toxicity of CTFE polymers have been investigated. To assess the toxicity of repeated exposure to HC 27-S, three groups of male and female Fischer-344 rats were dosed. Decreased water consumption and urine output were apparent in all test groups. Statistically significant increases in fluoride excretion were noted in 24-hr urine samples assessed periodically during the study. Neurotoxic signs were observed in female rats but not in male rats. Significant increases in liver and kidney weights were seen in all rats, regardless of number of dosing days. The increased fluoride burden in treated animals appeared sufficient to alter bone calcium/phosphate ratios in male rats but not female rats. Gross liver enlargement and hepatocellular cytomegaly indicated that the liver was probably the primary target organ following repeated administration of HC 27-S.

51863 (AD-A-223537/2/XAB) **2,3,7,8-tetrachlorodibenzo-p-dioxin pretreatment of female mice altered tissue distribution but not hepatic metabolism of a subsequent dose.** Curtis, L.R.; Kerkvliet, N.I.; Baecher-Steppan, L.; Carpenter, H.M. Oregon State Univ., Corvallis, OR (USA). Dept. of Fisheries and Wildlife. 1990. 10p. Grant AFOSR-87-0185. Source: NTIS, PC A02/MF A01.

Pub. in Fundamental and Applied Toxicology, Vol. 14, 523-531(1990).

Concern over environmental contamination with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) stimulated research of its toxic actions and underlying molecular events. Various epithelia, epithelial-derived tissues such as liver, and the immune system were identified as major target tissues. A toxic mechanism based upon interaction of TCDD with the Ah receptor and subsequent expression of a pleiotropic response provided an explanation for many reported phenomena. In light of the tissue and subcellular specificity of TCDD action, tissue distribution of a given dose likely has substantial effects on patterns of tissue damage. Further, chronic toxicity of repeated low doses may be influenced by factors which increase or decrease TCDD concentrations to which particular cell types are exposed.

51864 (KFK-PEF-57) **Local sensitization to inhalation antigens of bronchi previously damaged by inhalation of irritant gases (SO_2, NO_2, O_3 and tobacco smoke).** Riedel, F. (Marburg Univ. (Germany, F.R.). Zentrum fuer Kinderheilkunde); Rieger, C.H.L. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Jan 1990. 185p. (In German). Contract PEF 86/003/1C. Order Number DE91706018. Source: NTIS (US Sales Only), PC A09/MF A01.

The available evidence from epidemiologic studies and animal experiments suggests that there is a link between air pollution and the occurrence of diseases of allergic origin. The findings revealed on the basis of the animal model used here clearly pointed to the fact that exposure to pollutants and sensitive reactions to inhaled allergens are related in a causative way. For the purposes of this study, guinea-pigs were exposed to different concentrations of SO_2, NO_2, ozone and tobacco smoke before being challenged with ovalbumin, which was used as a sensitising inhalation allergen. After a recovery period, specific bronchial challenges, specific antibody determinations in the serum and bronchoalveolar lavage were employed to assess the degree of sensitisation to the inhaled allergen, which was then contrasted with that observed in control animals without previous lesions. It was found for all the pollutants examined here that the extent of sensitisation to the inhaled allergen decreased in proportion to the concentration of the toxins and the duration of exposure. (orig./MG).

51865 (OE/ARB-90-04213) **A survey to document the decline status of the sugar maple forest of Ontario, 1986.** McIlveen, W.D. (Ontario Ministry of the Environment, Toronto, ON (Canada)); McLaughlin, D.L.; Arnup, R.W. Ontario Ministry of the Environment, Toronto, ON (Canada). Air Resources Branch. Dec 1989. 80p. (MICROLOG-90-04213). Source: PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Air pollutants are alleged to contribute to regional forest decline. The severity and extent of decline has become more apparent, particulary in the last 10 to 15 years. In 1985, a survey was initiated to examine the decline conditions of Ontario's hardwood forest. Sugar maple was the primary target species, and determination of causal factors was not an objective, although some causal factors are discussed. In total, 110 plots were established and the initial evaluation of 11,000 trees was completed in 1986, using a numerical Decline Index rating system. Additional data regarding gross soil characteristics, stand sizes, disease and insect activity, and the frequency of tree stem defects were also collected. Hardwood forest decline was scattered in isolated areas of Ontario although regional patterns were evident. Generally, trees in the north tended to be in somewhat poorer condition than southern trees, although the southwestern area of the province also had a higher frequency of declining trees. Factors which may influence those results include the high sensitivity of northern soils to acidification by atmospheric pollutants and the high levels of air pollutant

deposition in the southwest. The survey plots in central Ontario consistently contained trees in good condition with a low frequency of decline. Two separate statistical analysis methods were used to confirm the regional decline pattern. Ranked in order of decline severity, the tree species which comprised greater than 1% of the sample population are: sugar maple < beech < white ash < basswood < yellow birch = red oak < red maple < ironwood < white birch < black cherry. 11 figs., 17 tabs.

51866 (ORNL/FTR-3768) **[Quantitative structure-activity relationships in environmental toxicology]: Foreign trip report, September 14, 1990-September 21, 1990.** Turner, J.E. Oak Ridge National Lab., TN (USA). 4 Oct 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000874. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the Fourth International Workshop on QSAR (Quantitative Structure-Activity Relationships) in Environmental Toxicology. He was an author or co-author on one platform and two poster presentations. The subject of the workshop offers a framework for analyzing and predicting the fate of chemical pollutants in organisms and the environment. QSAR is highly relevant to the ORNL program on the physicochemical characterization of chemical pollutants for health protection.

51867 (PB-90-247628/XAB) **Toxicological Profile for Tetrachloroethylene. Final report.** Syracuse Research Corp., NY (USA). Jan 1990. 119p. Contract EPA-68-C8-0004. Source: NTIS, PC A06/MF A01.

The ATSDR Toxicological Profile for Tetrachloroethylene is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

51868 (PB-90-256512/XAB) **Educating the public about the Health and Welfare Risks Associated with ground-level ozone. Technical report.** Boyer, M.A. Yale Univ., New Haven, CT (USA). School of Forestry and Environmental Studies. 1989. 79p. Source: NTIS, PC A05/MF A01.

The report is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The NNEMS research project recommends ways to increase media coverage of the poisonous ozone problem. Current media fails to discriminate between good ozone (stratospheric) and poisonous ozone (tropospheric) creating public confusion. Initial recommendation encourages the Agency to add an adjective to the word ozone to communicate a clear, powerful message vividly depicting the harmful distinction. EPA's poisonous ozone communications campaign hinges largely on its ability to capitalize on free media resources and educational institutions. A media kit developed for press members will facilitate television, radio and newspaper coverage of the summer ozone problem. The kits can be distributed at an EPA news conference directed at the poisonous ozone problem.

51869 (PB-90-262072/XAB) **Effects of acid fog on airway function in people with asthma. Final report.** Sheppard, D.; Balmes, J.R.; Christian, D. California Univ., San Francisco, CA (USA). Lung Biology Center. 30 Nov 1988. 206p. Contract ARB-A5-179-33. Source: NTIS, PC A10/MF A02.

The study was built on earlier work examining the effects of acidic fog on human subjects with asthma. Mouthpiece exposure studies on asthmatic subjects showed that both nitric and sulfuric acids potentiate the bronchoconstrictor effects of fog water, and that these acids appear to be similar in this respect. The work resulted in the exposure chamber at the University of California, San Francisco being extensively modified, based on improvements recommended in an earlier investigation, thus allowing human subjects to be exposed to rigorously controlled and monitored test fogs. The study used the chamber to first examine the effects of fog without acid, and then the effects of fog with acid, on exercising subjects with asthma.

51870 (PNL-7432) **Analysis of health impact inputs to the US Department of Energy's risk information system.** Droppo, J.G. Jr.; Buck, J.W.; Strenge, D.L.; Siegel, M.R. Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 86p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE91000174. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE) is in the process of completing a survey of environmental problems, referred to as the Environmental Survey, at their facilities across the country. The DOE Risk Information System (RIS) is being used to prioritize these environmental problems identified in the Environmental Survey's findings. This report contains a discussion of site-specific public health risk parameters and the rationale for their inclusion in the RIS. These parameters are based on computed potential impacts obtained with the Multimedia Environmental Pollutant Assessment System (MEPAS). MEPAS is a computer-based methodology for evaluating the potential exposures resulting from multimedia environmental transport of hazardous materials. This report has three related objectives: document the role of MEPAS in the RIS framework, report the results of the analysis of alternative risk parameters that led to the current RIS risk parameters, and describe analysis of uncertainties in the risk-related parameters. 20 refs., 17 figs., 10 tabs.

51871 (QME-PA-34) **Effects of acidity on the fish populations of the north Mauricie.** Tremblay, S. Quebec Ministere de l'Environnement, Ste-Foy, PQ (Canada). Jul 1989. 94p. (MICROLOG-90-02961). Source: PC Quebec Ministere de l'environnement, 3900, rue Marly, Ste Foy, PQ, CAN G1X 4E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN.

Since summer 1987, sampling has been carried out on the fish populations of 30 lakes in the northern part of the Mauricie hydrographic region in Quebec in order to evaluate the impact of lake acidity on fish. Analysis of the results of experimental fishing shows that fish diversity is not influenced directly by environmental acidity. Nevertheless, it seems that a pH of 5.3-5.5 is the lower limit of the resistance to acidity of the majority of the fish species. Perca flavescens and Esox lucius are the most resistant species, as well as most of the cyprinids. Salmonids, as well as Lotta lotta and Cottus bairdi, are the most sensitive to lake acidity. In addition, the increase in acidity brings with it a reduction in the density of Semotilus margarita and Salvelinus fontinalis in the lakes with communities of Catostomus commersoni. For the fish predator community, no species seems directly affected by the increase in acidity. In any event, the aluminum concentration seems to have had more important adverse effects on the fish fauna of the two communities. The decrease in density of Semotilus margarita and Stizostedion vitreum is related to the increase in aluminum concentration in the environment. As well, the biomass and average weight of Semotilus corporalis is equally affected by aluminum. The analysis of the size distributions of P. flavescens, S. vitreum and S. fontinalis populations living in acid waters reveals the absence of numerous size categories which, nevertheless, are present in lakes of transitional acidity (pH 5.5-6) and non-acid lakes. 90 refs., 46 figs., 5 tabs.

51872 **Lichens as air pollution biomonitors in a semiarid environment in Idaho.** Rope, S.K. (Dept. of Energy, Idaho Falls, ID (USA)); Pearson, L.C. *Bryologist (USA)*, 93(1): 50-61 (Spr 1990).

Two measurement techniques were employed to evaluate the feasibility of using lichens as in situ biomonitors of atmospheric pollution in a semiarid climate - trace element analysis and electrolyte leakage from cells. Trace element concentrations were generally higher in Lecanora melanophthalma (ram.) Ram. tissues

than previously measured in sagebrush (Artemisia tridentata) and perennial grasses from the same locations, but lower than in soil. Lichens from an urban area (Idaho Falls) had statistically higher concentrations of ten elements, particularly lead and zinc, than those from the Idaho National Engineering Laboratory (INEL) and Craters of the Moon National Monument. Levels of fluoride, nickel, and seven other elements were high at the INEL relative to the other sites. Thalli collected downwind from the Idaho Chemical Processing Plant (ICPP) at the INEL were significantly higher in boron and lead content than those collected at crosswind locations: levels of eleven elements were significantly higher in lichens collected at 5 or 10 km from the ICPP than in those collected at 2 km. Electrolyte leakage was greatest from thalli collected in the nighttime downwind direction from the ICPP, even though daytime winds, which blow in the opposite direction, are more frequent, suggesting that in a semiarid climate, injury from atmospheric SO_2 and NO_x pollution in lichen tissues is greatest when the thalli are moist from morning dew or other sources. These results demonstrate that some lichen species, especially Lecanora melanophthalma, have potential for biomonitoring of atmospheric pollutants in the semiarid regions of the Intermountain West.

51873 **Response of rat tracheal epithelium to ozone and oxygen exposure in vitro.** Nikula, K.J. (Inhalation Toxicology Research Institute, Albuquerque, NM (USA)); Wilson, D.W. *Fundamental and Applied Toxicology (USA),* 15(1): 121-131 (Jul 1990).

Although ozone-induced epithelial injury in vivo has been morphologically characterized, effects of gaseous oxidants on respiratory epithelium in organ culture, where tissue organization is maintained but systemic influences are eliminated, have not been thoroughly investigated. In this study, we exposed tracheal organ cultures from rats to 95% oxygen and 1 ppm ozone, alone and in combination, to determine (1) whether epithelial responses to ozone similar to those observed in vivo occur in airways separated from systemic physiologic, secretory, and inflammatory reactions; (2) whether concentrations of oxygen sufficient to potentially cause oxidant injury result in morphologic epithelial alterations similar to those that occur in ozone toxicity; and (3) if the combined oxidant insult of oxygen and ozone results in more severe damage to the tracheal epithelium than occurs with ozone in air. Tracheal organ cultures were exposed to filtered air and 5% carbon dioxide; filtered air, 5% carbon dioxide, and 1 ppm ozone; 95% oxygen and 5% carbon dioxide; or 95% oxygen, 5% carbon dioxide, and 1 ppm ozone for 96 hr. Light- and quantitative electron-microscopic evaluation showed that epithelia exposed to 1 ppm ozone in air exhibited loss of ciliated cells and ciliated cell damage. The epithelia exposed to 95% oxygen and 5% carbon dioxide were pseudostratified, columnar, ciliated, and hyperplastic. Epithelia exposed to 95% oxygen plus 1 ppm ozone were stratified and nonciliated or very sparsely ciliated. The predominant cell types in epithelia exposed to oxygen plus ozone were serous cells and metaplastic cells, and focal aggregates of adherent necrotic cells were present. We conclude that there was a synergism between oxygen and ozone exposure leading to enhanced epithelial injury and metaplasia.

51874 **Concentrations of selected chlorinated pesticides in shrimp collected from the Calcasieu River/Lake Complex, Louisiana.** Murray, H.E. (McNeese State Univ., Lake Charles, LA (USA)); Beck, J.N. *Bulletin of Environmental Contamination and Toxicology (USA),* 44(5): 798-804 (May 1990).

For several decades inland and coastal aquatic ecosystems have been affected by a multitude of synthetic chemical substances. This is a consequence of population growth and increased industrial and agricultural activity. Many of these chemicals, the by-products of their production, and degradation products ultimately find their way into the aquatic environment as pollutants. The extent to which these pollutants affect the environment and its inhabitants depends largely upon the quantity and nature of the particular compounds involved. Halogenated hydrocarbons, particularly polychlorinated biphenyls (PCBs), and the pesticide DDT and its degradation products have received much attention as environmental pollutants. Because of the economic importance of the shrimping industry to southwest Louisiana, the objective of this study was to analyze shrimp collected from the Calcasieu River/Lake Complex for the presence of selected chlorinated pesticides. The presence of these compounds within shrimp tissues would serve as an indicator for the extent of pollution throughout this important estuarine system.

51875 **Optimization of surface sterilization for legume seed.** Caetano-Anolles, G. (Univ. of Tennessee, Knoxville (USA)); Favelukes, G.; Bauer, W.D. *Crop Science (USA),* 30(3): 708-712 (May-Jun 1990). DOE Contract FG02-86ER13522.

Roots of alfalfa (Medicago sativa L.), white clover (Trifolium repens L.), and soybean [Glycine max (L.) Merr.] seedlings are frequently contaminated with bacteria even after surface sterilization of the seeds and germination under aspetic conditions. Several seed-sterilization procedures were compared for their ability to minimize or eliminate such contamination without damaging the plant. Mercuric chloride proved the best seed disinfectant for alfalfa and white clover. Calcium hypochlorite was the best for soybean. For alfalfa seeds, treatment with 95% ethanol (v/v) for 60 min followed by 0.2% $HgCl_2$ (v/v) for 15 min prior to rinsing and imbibition resulted in a low frequency (< 5%) of seed and root contamination. This treatment resulted in no measurable damage to alfalfa seedlings with respect to root growth, nodulation efficiency, or rate of nodule emergence following inoculation with Rhizobium meliloti. Longer exposures to $HgCl_2$ further reduced bacterial contamination, but also caused modest reductions in seed germination. None of the surface-sterilization techniques tested completely eliminated bacterial contaminants. It appears that these sterilization-resistant contaminants are borne within the seed and proliferate on plant surfaces after germination, with possible effects on plant health.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 50908

51876 (AD-A-223360/9/XAB) **Effects of electric fields on membrane-bound Na, K-ATPase. Progress report, 1 July 1989-30 June 1990.** Tsong, T.Y. Minnesota Univ., St. Paul, MN (USA). Dept. of Biochemistry. 30 Jun 1990. 8p. Contract N00014-88-J-1220. Source: NTIS, PC A02/MF A01.

We continued to work on effects of oscillating electric fields on membrane functions, in particular the electric activation of Na, K-ATPase, and to develop theory of electro-conformational coupling. We believe transmembrane electric fields are involved in the regulation of the internal activity of a cell and also in the cell-to-cell communications. An in depth study of Na, K-ATPase will provide useful information concerning the molecular design of a cell to sense and to transmit signals.

51877 (AD-A-223397/1/XAB) **Interaction of electromagnetic fields with chondrocytes in gel culture. Final report, February-August 1989.** Grodzinsky, A.J.; Gluzband, Y.A.; Buschmann, M.D. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Electrical Engineering and Computer Science. Feb 1990. 32p. Contract F33615-87-D-0626. Source: NTIS, PC A03/MF A01.

The research accomplished during this project period focused on control experiments designed to establish whether cartilage cells from normal cartilage will continue to synthesize and accumulate normal extracellular matrix in agarose gel culture. This information is essential to properly design experiments to qualify changes in chondrocyte biosynthesis due to applied electromagnetic fields. The results suggest that both normal chondrocytes and swarm rat chondrosarcoma cells in agarose culture can continue to synthesize matrix macromolecules at a rate similar to or slightly higher than that in normal cartilage; also, that chondrocytes in agarose can successfully mediate assembly and accumulation of normal, mechanically functional extracellular matrix.

51878 (MIC-90-03856/XAB) **Electric and magnetic fields and your health: A report.** Working Group on Electric and Magnetic ELF Fields, Ottawa, ON (Canada). ©1990. 34p. (SSC-H-46-2/89-150E). Source: NTIS, PC EE07/MF E01.

Text in English and French (Bilingual). French ed. on the same fiche.

There has been increased concern regarding health effects of extremely low frequency ELF (1-300 Hz) electric and magnetic fields, particularly of those produced by power lines. In response to this concern, a working group representing labour, utility companies, academia, and federal and provincial governments was

formed in 1986 to assess the existence and scope of health effects of electric and magentic fields related to the generation and use of electricity, to identify gaps in knowledge, to foster research to fill these gaps, and to educate the public on the state of scientific understanding. This document was prepared to educate the public regarding health effects of exposure to electric and magnetic fields at 60 Hz. Reports on the Working Group's activities, conclusions and recommendations are also included.

57 HEALTH AND SAFETY

Refer also to citation(s) 51885

51879 (DOE/EH–0141) **Tiger Team Assessment of the Sandia National Laboratories, Livermore, California.** USDOE, Washington, DC (USA). Aug 1990. 709p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90018024. Source: NTIS, PC A99/MF A01 - OSTI; GPO Dep.

This report provides the results of the Tiger Team Assessment of the Sandia National Laboratories (SNL) in Livermore, California, conducted from April 30 to May 18, 1990. The purpose of the assessment was to provide the Secretary of Energy with the status of environment, safety and health (ES&H) activities at SNL, Livermore. The assessment was conducted by a team consisting of three subteams of federal and private sector technical specialists in the disciplines of environment, safety and health, and management. On-site activities for the assessment included document reviews, observation of site operations, and discussions and interviews with DOE personnel, site contractor personnel, and regulators. Using these sources of information and data, the Tiger Team identified a significant number of findings and concerns having to do with the environment, safety and health, and management, as well as concerns regarding noncompliance with Occupational Safety and Health Administration (OSHA) standards. Although the Tiger Team concluded that none of the findings or concerns necessitated immediate cessation of any operations at SNL, Livermore, it does believe that a sizable number of them require prompt management attention. A special area of concern identified for the near-term health and safety of on-site personnel pertained to the on-site Trudell Auto Repair Shop site. Several significant OSHA concerns and environmental findings relating to this site prompted the Tiger Team Leader to immediately advise SNL, Livermore and AL management of the situation. A case study was prepared by the Team, because the root causes of the problems associated with this site were believed to reflect the overall root causes for the areas of ES&H noncompliance at SNL, Livermore. 4 figs., 3 tabs.

51880 (LA–11661-MS-Vol.2) **Guidance for the preparation of Safety Analysis Reports: Volume 2, Performing safety analyses.** Howard, H.H.; Faust, C.L. Los Alamos National Lab., NM (USA). Jun 1990. 72p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-7405-ENG-36. Order Number DE91000452. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This document provides guidance on the safety analysis process. The interface between safety analysis and design is discussed, concepts and activities important to safety analysis are described, and a discussion of risk analysis techniques is presented. 16 refs., 18 figs., 10 tabs.

51881 (STEV–1989-R14) **Working environment/energy production.** Hagerman, Y. Statens Energiverk, Stockholm (Sweden). Dec 1989. 290p. (In Swedish). Order Number DE91707852. Source: NTIS (US Sales Only), PC A14/MF A01.

Basic documment to the report 'An environmentally adapted energy system', STEV–1990-2.

The aim of this report is to elucidate risks in the working environment and industrial injuries caused during different phases and processing steps in connection with power production. Part 2 of the report describes the conditions for wind power plants and solar power plants. For wind power the important differences between land- and sea-based sitings is observed. For solar power, the climate in Sweden excludes everything but photovoltaic power. Part 3 concerns nuclear power, from the uranium milling to the final storage of radioactive wastes. Part 4 give details for coal-, oil- and chipburning facilities as well as for power plants fuelled with peat and natural gas. For all of the alternatives, statistical data is presented covering fatal injuries, total number of injuries, and lost work days. (U.W.).

58 GEOSCIENCES

Refer also to citation(s) 50504, 50534, 50596, 50597, 50598, 50599, 50600, 50606, 50624, 50625, 50626, 50627, 50628, 50629, 50630, 50631, 50633, 51082, 51723, 51724, 51763, 51896

51882 (AD-A–223574/5/XAB) **Liquefaction mitigation technology. Final report, February 1988–June 1989.** Millea, M.T. Naval Civil Engineering Lab., Port Hueneme, CA (USA). Feb 1990. 37p. (NCEL-TN–1808). Source: NTIS, PC A03/MF A01.

Seismically-induced soil liquefaction is a great threat to the Navy's huge shore facility investment located at the waterfront. Improvement of potentially liquefiable soil beneath and surrounding structures is currently feasible. Using empirical design methods, the construction of stone columns on relatively close centers provides increased resistance to lateral loading from earthquake waves and increases vertical drainage by reducing the radial flow path, which can increase the rate of dissipation of pore water pressure. A background investigation of state-of-the-art soil improvement methods was conducted. The Princeton Effective Stress Soil Model was evaluated as a tool to aid the design of soil improvement methods. Finite element models with and without stone columns were subjected to simulated earthquake excitation using DYNAFLOW, a finite element computer model developed at Princeton University to analyze dynamic soil-structure interaction problems. Results indicate that the stone columns improved site conditions and decreased damage due to vibratory motion. The results also indicated that each potentially liquefiable site is unique and will require individual analysis.

51883 (INP–1397/AP) **SLOWN2.BAS program for calculation of the rock neutron slowing down parameters.** Czubek, J.A. Institute of Nuclear Physics, Cracow (Poland). 1988. 53p. Order Number DE91604878. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

BASIC/IBM PC.

The most important parameter needed in numerous methods of neutron calculations in nuclear geophysics is the slowing down length value for a given rock. The SLOWN2.BAS program written in BASIC for the IBM PC was written for this purpose. The model of the rock taken for calculation is a rock matrix which can contain such elements as H, B, C, N, O, F, Na, Mg, Al, Si, Cl, K, Ca, Ti, Cr, Mn, Fe, Ni, Pb. The pore space of the rock can be filled with brine of a given salinity (in ppm of NaCl) and with hydrocarbons of the form $n.CH_x$. The calculation can be performed for different neutron sources: Ra-Be, Po-Be, Am-Be, Cf-252, 14 MeV, 10.5 MeV, 6.5 MeV, 4.0 MeV, 2.5 MeV, 1.4 MeV, 0.8 MeV, 0.4 MeV, 0.2 MeV and 0.1 MeV using the 26 neutron group cross section library introduced by another program called NEWCROSS.BAS. Further parameters calculated by the SLOWN2.BAS program are: the effective diffusion coefficient for the neutron slowing down process, the neutron slowing down time, the probability of the neutron escaping absorption during the slowing down process and the space integrated spectrum of the neutron flux as a function of the neutron lethargy. All results can be stored on a disk and retrieved afterwards using an auxiliary program REPRO2.BAS also included in this report. (author).

51884 (IS-IPRT–7) **Iowa State Mining and Mineral Resources Research Institute: Final report, July 1, 1989–June 30, 1990.** Iowa State Univ. of Science and Technology, Ames, IA (USA). Iowa State Mining and Mineral Resources Research Inst. Aug 1990. 134p. Sponsored by U.S. Department of the Interior. DOE Contract W-7405-ENG-82. Order Number DE91000572. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This final report describes the activities of the Iowa State Mining and Mineral Resources Research Institute (ISMMRRI) at Iowa State University for the period July 1, 1989, to June 30, 1990. Activities include research in mining- and mineral-related areas, education and training of scientists and engineers in these fields,

administration of the Institute, and cooperative interactions with industry, government agencies, and other research centers. During this period, ISMMRRI has supported research efforts to: (1) Investigate methods of leaching zinc from sphalerite-containing ores. (2) Study the geochemistry and geology of an Archean gold deposit and of a gold-telluride deposit. (3) Enchance how-quality aggregates for use in construction. (4) Pre-clean coal by triboelectric charging in a fluidized-bed. (5) Characterize the crystal/grain alignment during processing of yttrium-barium-copper-perovskite (1-2-3) superconductors. (5) Study the fluid inclusion properties of a fluorite district. (6) Study the impacts of surface mining on community planning. (7) Assess the hydrophobicity of coal and pyrite for beneficiation. (8) Investigate the use of photoacoustic absorption spectroscopy for monitoring unburnt carbon in the exhaust gas from coal-fired boilers. The education and training program continued within the interdepartmental graduate minor in mineral resources includes courses in such areas as mining methods, mineral processing, industrial minerals, extractive metallurgy, coal science and technology, and reclamation of mined land. In addition, ISMMRRI hosted the 3rd International Conference on Processing and Utilization of High-Sulfur Coals in Ames, Iowa. The Institute continues to interact with industry in order to foster increased cooperation between academia and the mining and mineral community.

51885 (KY/H–111) **Seismic issues at the Paducah Gaseous Diffusion Plant.** Fricke, K.E. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)). Paducah Gaseous Diffusion Plant, KY (USA). Nov 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OU21400. (CONF-8903247–1: Seismic expert workshop, Puducah, KY (USA), 13-15 Mar 1989). Order Number DE91000573. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A seismic expert workshop was held at the Paducah Gaseous Diffusion Plant (PGDP) on March 13–15, 1989. the PGDP is operated by Martin Marietta Energy Systems, Inc. for the United States Department of Energy (DOE). During the last twenty years the design criteria for natural phenomenon hazards has steadily become more demanding at all of the DOE Oak Ridge Operations (ORO) sites. The purpose of the two-day workshop was to review the seismic vulnerability issues of the PGDP facilities. Participants to the workshop included recognized experts in the fields of seismic engineering, seismology and geosciences, and probabilistic analysis, along with engineers and other personnel from Energy Systems. A complete list of the workshop participants is included in the front of this report. 29 refs.

51886 (LBL–29257) **Acoustic emission in a fluid saturated heterogeneous porous layer with application to hydraulic fracture.** Nelson, J.T. (California Univ., Berkeley, CA (USA). Dept. of Mechanical Engineering). Lawrence Berkeley Lab., CA (USA). Nov 1988. 272p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE91000223. Source: NTIS, PC A13/MF A01 - OSTI; GPO Dep.

A theoretical model for acoustic emission in a vertically heterogeneous porous layer bounded by semi-infinite solid regions is developed using linearized equations of motion for a fluid/solid mixture and a reflectivity method. Green's functions are derived for both point loads and moments. Numerically integrated propagators represent solutions for intermediate heterogeneous layers in the porous region. These are substituted into a global matrix for solution by Gaussian elimination and back-substitution. Fluid partial stress and seismic responses to dislocations associated with fracturing of a layer of rock with a hydraulically conductive fracture network are computed with the model. A constitutive model is developed for representing the fractured rock layer as a porous material, using commonly accepted relationships for moduli. Derivations of density, tortuosity, and sinuosity are provided. The main results of the model application are the prediction of a substantial fluid partial stress response related to a second mode wave for the porous material. The response is observable for relatively large distances, on the order of several tens of meters. The visco-dynamic transition frequency associated with parabolic versus planar fluid velocity distributions across micro-crack apertures is in the low audio or seismic range, in contrast to materials with small pore size, such as porous rocks, for which the transition frequency is ultrasonic. Seismic responses are predicted for receiver locations both in the layer and in the outlying solid regions. In the porous region, the seismic response includes both shear and dilatational wave arrivals and a second-mode arrival. The second-mode arrival is not observable outside of the layer because of its low velocity relative to the dilatational and shear wave propagation velocities of the solid region.

51887 (MIC–90-04256/XAB) **Radiocarbon dates from the western basin of the Champlain Sea. Paper No. 89-22.** Richard, S.H. Geological Survey of Canada, Ottawa, ON (Canada). ©1989. 23p. (SSC-M–44-89/22E). Source: NTIS, PC EE07/MF E01.

S.H. Richard spent much of his career mapping and conducting Quaternary research in the Ontario-Quebec region near Ottawa. His work in the Ottawa area was conducted from 1970-87 and one of his main goals was to develop a radiocarbon chronology for the Champlain Sea. This report assembles all of these dates as an inventory and also contains a brief summary of the interpretations that Richard placed on these ages.

51888 (NUREG/CR–5258-Vol.3) **Georgia/Alabama regional seismographic network: Volume 3, Annual report, July 1987–June 1988.** Long, L.T. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Georgia Inst. of Tech., Atlanta, GA (USA). School of Earth and Atmospheric Sciences. Sep 1990. 101p. Sponsored by Nuclear Regulatory Commission. Source: NTIS, PC A06/MF A01 - GPO - OSTI.

A review of the historical seismicity of southeastern Tennessee suggests that the period of 1970 through 1988 was anomalously more active then before 1970. If this is true, then is represents a unique stress release event that would satisfy the model for major intraplate earthquakes proposed by Long (1988). First motion data and SV/P amplitude ratios were used to determine 36 single events and two composite focal mechanism solutions for earthquakes in southeastern Tennessee. The dominant focal mechanism is strike slip with reverse or normal fault components. Linearizing the relation between measured apparent coda Q and assumed constant coda Q for discrete zones of crust suggests an anomalously low (Q = 50) region northeast of station CBT. Fracture density was mapped in an area of induced seismicity near Clarks Hill Reservoir. It appears that areas of higher joint spacing correspond to zones of induced seismicity. In this and other reservoirs, earthquakes tend to occur in granite gneiss where jointing is sparse and the rock is strong. Seismic activity is not often observed in foliated schists and altered mafic rocks, in which stress may be released through creep.

51889 (USGS-OFR–90-87) **Compilation of modal analyses of volcanic rocks from the Nevada Test Site area, Nye County, Nevada.** Page, W.R. Geological Survey, Denver, CO (USA). 1990. 179p. Sponsored by U.S. DOE Radioactive Waste Management; U.S. Geological Survey. DOE Contract AI08-78ET44802. Order Number DE91000132. Source: NTIS, PC A09/MF A01; OSTI; INIS; USGS, Books and Open-File Reports Section, Box 25425 Federal Center, Denver CO 80225; GPO Dep.

Volcanic rock samples collected from the Nevada Test Site, Nye County, Nevada, between 1960 and 1985 were analyzed by thin section to obtain petrographic mode data. In order to provide rapid accessibility to the entire database, all data from the cards were entered into a computerized database. This computer format will enable workers involved in stratigraphic studies in the Nevada Test Site area and other locations in southern Nevada to perform independent analyses of the data. The data were compiled from the mode cards into two separate computer files. The first file consists of data collected from core samples taken from drill holes in the Yucca Mountain area. The second group of samples were collected from measured sections and surface mapping traverses in the Nevada Test Site area. Each data file is composed of computer printouts of tables with mode data from thin section point counts, comments on additional data, and location data. Tremendous care was taken in transferring the data from the cards to computer, in order to preserve the original information and interpretations provided by the analyzer. In addition to the data files above, a file is included that consists of Nevada Test Site petrographic data published in other US Geological Survey and Los Alamos National Laboratory

reports. These data are presented to supply the user with an essentially complete modal database of samples from the volcanic stratigraphic section in the Nevada Test Site area. 18 refs., 4 figs.

51890 Geologic significance of remotely sensed physiographic features of the Texas Panhandle and adjacent regions. Collins, E.W. 39p. University of Texas Bureau of Economic Geology, Austin, TX (USA) (1990).

Remotely sensed features such as linear drainages, escarpments, ridges, and aligned playas were identified on 1:250,000-scale Landsat images of the Texas Panhandle, eastern New Mexico, and the Oklahoma Panhandle and compared with detailed regional and site-specific geologic data from 32 field stations in these areas. The physiographic regions studied are the High Plains, Canadian Breaks, Rolling Plains, Pecos Valley, and Raton section. The authors collected structural data at the near features depicted on the 63 remotely sensed images, thus providing a case study of the correlation of surface and subsurface geologic data with remotely sensed features in areas of differing physiography. Results show that about 70 percent of the drainages, escarpments, and ridges coincide with the orientations of fracture sets, faults, or dikes in all areas except the low-relief High Plains. Detailed statistical analyses of lineaments performed for this study indicate that lineament interpretations only partly reflect the orientations of fracture sets and the structural grains of subsurface strata; thus, the combination of remotely sensed data and geologic data offers a more complete assessment of the surficial geology of the Texas Panhandle.

51891 Uses of probability graphs for the characterization of fractured rock aquifers near Oak Ridge, Tennessee. Moore, G.K. (Oak Ridge National Laboratory, TN (USA)). pp. 57-65 of Recent advances in ground-water hydrology. Moore, J.E.; Zaporozec, A.A.; Csallany, S.C.; Varney, T.C. (eds.). American Institute of Hydrology, Minneapolis, MN (US) (1989). pp. 645 DOE Contract AC05-84OR21400. (CONF-881166–: Symposium on recent advances in ground-water hydrology, Tampa, FL (USA), 16-19 Nov 1988).

Hydrologic parameters in the fractured rock aquifers near Oak Ridge National Laboratory have a large numeric range, little correlation with other parameters, and abrupt changes in spatial relationships. Tools such as contour maps and regression analyses have limited utility in this area and can produce misleading results. The problem apparently results from nearly unique conditions along each of the many aquifer flow paths. In this situation, the best approach to parameter characterization may be a graphical method of statistical analysis. Cumulative probability graphs require a fairly large amount of data but may show sample or population deviations that otherwise would have been obscure. Some deviations represent only an imperfect distribution of sample values, but others show some type of control on population characteristics. A correct interpretation of the significant deviations can contribute to an understanding of groundwater occurrence and flow paths. All tested parameters in the study area plot as lognormal distributions. On each graph, the slope of the fitted population line shows the change in probability per unit change in parameter value. Any classification of data within a population shows differences, which may or may not be statistically significant, in geometric means and shows nearly identical standard deviations.

51892 Advances in coupling hydrologic transport and geochemical equilibria. Yeh, G.T. (Oak Ridge National Laboratory, TN (USA)); Tripathi, V.S. pp. 380-393 of Recent advances in ground-water hydrology. Moore, J.E.; Zaporozec, A.A.; Csallany, S.C.; Varney, T.C. (eds.). American Institute of Hydrology, Minneapolis, MN (US) (1989). pp. 645 (CONF-881166–: Symposium on recent advances in ground-water hydrology, Tampa, FL (USA), 16-19 Nov 1988).

Three approaches have been used to formulate the coupled hydrologic transport and geochemical equilibria of reactive multispecies systems: (1) the mixed differential and algebraic equation (DAE) approach, (2) the direct substitution approach (DSA), and (3) the sequential iteration approach (SIA). An extremely important consideration in any approach is the choice of primary dependent variables (PDVs). Six types of PDVs have been employed in the existing models: (1) concentrations of all species, (2) concentrations of all component species and precipitated species, (3) total analytical concentrations of aqueous components, (4) total dissolved concentrations of aqueous components, (5) concentrations of aqueous component species, and (6) hybrid (combination of) concentrations. Because of many possible combinations of PDVs and approaches, many hydrogeochemical transport models for multi-species systems have been developed. This paper review and evaluates these models in terms of: (1) the requirement of computing resources, (2) the variety of geochemical processes, and (3) extendibility to include mixed kinetic and equilibrium reactions.

51893 The long-term measurement of strong-motion earthquakes offshore southern California. Sleefe, G.E. (Sandia National Labs., Albuquerque, NM (USA)). pp. 561-568 of Proceedings of the 22nd annual offshore technology conference: Volume 2. Offshore Technology Conference, Richardson, TX (USA) (1990). pp. 649 DOE Contract AC04-76DP00789. (CONF-900507–: 22. offshore technology conference and exhibition (OTC '90), Houston, TX (USA), 7-10 May 1990).

Technical Paper OTC 6336.

This paper describes a new long-life seafloor earthquake measurement system (SEMS) and presents earthquake data obtained from the seafloor near an offshore oil production field. The SEMS is a battery-powered (8 year life) digital data acquisition system which telemeters data via a sonar link. Seafloor earthquake data from SEMS indicate the seafloor vertical acceleration is nearly an order of magnitude weaker than the corresponding on-shore vertical motions. The importance of the SEMS measurements in designing earthquake-resistant offshore structures is also described.

51894 High resolution subsurface imaging with geophysical diffraction tomography. King, W.C. (Fitzsimons Army Medical Center, Aurora, CO (USA)); Witten, A.J. pp. 813-826 of The proceedings of the third national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods. National Water Well Association, Dublin, OH (US) (1989). pp. 1161 (CONF-8905127–: 3. National Water Well Association outdoor action conference, Orlando, FL (USA), 22-25 May 1989).

This paper describes the evolution of a promising new technique for subsurface remote sensing, geophysical diffraction tomography, from its theoretical formalism to its current state as a proven field technique capable of high resolution imaging of natural and buried subsurface features. The paper begins with a brief introduction of the concept of diffraction tomography and a review of the theoretical development of a scheme for implementing diffraction tomography in a geophysical imaging technique. Next, the field procedure is described. The final topic for this paper, and its primary objective, is to present results of three recent field tests of the system.

51895 Theis' contribution and parallel developments in the earth sciences. Narasimhan, T.N. (Lawrence Berkeley Laboratory, CA (USA)). pp. XXXII-XXXVII of Recent advances in ground-water hydrology. Moore, J.E.; Zaporozec, A.A.; Csallany, S.C.; Varney, T.C. (eds.). American Institute of Hydrology, Minneapolis, MN (US) (1989). pp. 645 DOE Contract AC03-76SF00098. (CONF-881166–: Symposium on recent advances in ground-water hydrology, Tampa, FL (USA), 16-19 Nov 1988).

The fact that Charles V. Theis has a unique position in the history of groundwater hydrology is well attested by this conference, which seeks to pay tribute to his memory. Theis made his noteworthy contribution on unsteady groundwater flow during a period when exciting progress was being made in many disciplines closely related to groundwater hydrology. This paper is a commemoration which reflects on the evolution of ideas in hydrogeology during a period from the early 1920's to the early 1940's. The philosophical importance of Theis' contribution lies in the recognition of the importance of the time dimension and the related recognition that time cannot be formally considered without the storage term. In a broad sense, the development of the idea of storage coefficients provided a basis for unifying the diverse perspectives of Gardner, Terzaghi, Richards, Hurst, Muskat, Theis and numerous others which are discussed in this text.

64 PHYSICS I

Refer also to citation(s) 50990

6401 Astrophysics and Cosmology

Refer also to citation(s) 51942, 52014, 52035, 52100, 52133, 52543

51896 (AD-A–223355/9/XAB) **Feasibility of cosmic-ray-muon intensity measurements for tunnel detection. Final report, February 1989-February 1990.** Celmins, A. Army Armament Research and Development Command, Aberdeen Proving Ground, MD (USA). Ballistics Research Lab. Jun 1990. 40p. (BRL-TR–3110). Source: NTIS, PC A03/MF A01.

Subsurface cosmic-ray muon intensity depends on the amount of material above the point of reference and is therefore influenced by anomalies in rock density. Because such anomalies might be caused by geological structures (e.g. ore bodies), cosmic-ray intensity measurements have been used for geophysical exploration. Recently, cosmic-ray muon intensity measurements have been also proposed as a method to detect tunnels. The feasibility of this application depends on the type of radiation detection apparatus (it must fit into a bore hole) and on the magnitude of the signal by a tunnel. If the signal is too weak, then the required observation times are estimated for a projected bore-hole radiation detector and for tunnels with a 2 m diameter. The estimates show that a reasonable upper bound for the detector depth is about 30 to 40 m if the observations are to be used in a tomographic reconstruction of th density field. The required observation times at that depth are of the order of days. The upper bound for the depth of detectable tunnels is less than the quoted bound for the detector depth. It might be possible to use the method at greater depths if special data interpretation techniques are developed that take into account prior knowledge about the tunnel, e.g. its anticipated direction.

51897 (AD-A–223428/4/XAB) **5-minute oscillation in the solar photosphere: Theoretical behavior versus observations.** Marmolino, C.; Stebbins, R.T. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1989. 9p. (GL-TR–90-0164). Source: NTIS, PC A02/MF A01.

Pub. in Societa Astronomica Italiana, Memorie, Vol. 60, No. 1-2, 71-78(1989).

Computed and observed frequencies, for the five minute oscillation, disagree is a significant way for the higher degree modes, indicating that the models cannot adequately represent these modes in the very surface layers where they are confined. To examine if and how these discrepancies extend to the eigenfunctions, we report detailed comparisons between theoretical and empirical eigenfunctions of velocity and intensity for the five minute modes in the photosphere. The comparison process is accomplished by obtaining synthetic profiles of the FeI lambda 5434 lambda line in the presence of waveforms given by dynamical calculations and then applying a common procedure of reduction both to the observed and to the synthetic data. For the velocity waveforms, our results show a general agreement between theory and observations together with some systematic differences; in particular the theory systematically underestimates the observations in the low photosphere. These systematic differences are stressed by the intensity results since both the computed amplitudes and phases appear to be wrong, particularly in the deeper layers.

51898 (AD-A–223607/3/XAB) **Simulation of large-scale flows at the solar surface.** Simon, G.W.; Weiss, N.W. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 15 Oct 1989. 20p. (GL-TR–90-0160). Source: NTIS, PC A03/MF A01.

Pub. in Astrophysical Jnl. Vol. 345, 1060-1078(15 Oct 1989).

A simple analytic axisymmetric function will represent the radial outflow associated with an isolated convection plume at the solar surface. The vertical velocity can be deduced from the continuity equation. A regular cellular pattern of convection can be created by superposing a number of such sources. Our motivation for this study came from the large-scale horizontal motions observed by the SOUP instrument on Spacelab 2. The flow pattern is simulated as visible in three different regions covered by the SOUP observations. In each case a superposition of our plume functions mimics the observed mesogranular and supergranular motions remarkably well. The model can be improved by using the same procedure to represent sinks as well as sources in the observed velocity field. We use these model flows to compute the motion of passive test particles (corks) which accumulate in a network that outlines mesogranular cells. The cork patterns closely resemble the magnetic network observed at the time of the SOUP measurements. Detailed comparisons suggest that magnetic flux tubes are affected more by outflow from sources at the centers of mesogranules than by flow into sinks within the network.

51899 (ESA-SP–302) **Physics and Mechanics of Cometary Materials.** Hunt, J.; Guyenne, T.D. (eds.). European Space Agency, 75 - Paris (France). 1989. 246p. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

In these proceedings the following questions are reported: comet missions and comet models, review of physical and compositional comet nucleus models, physical and chemical properties of ices and ice-dust mixtures.

51900 (ESA-SP–302, pp. 89-94) **Stable isotope studies of cometary analogue materials.** Franchi, I.A. (Open Univ., Milton Keynes (UK)); Alexander, C.M.O.; Pillinger, C.T.; Alexander, C.M.O.; Mendoza-Gomez, C.X.; Greenberg, J.M. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials*. 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Some preliminary experiments exploring the isotopic exchange of water and CO_2 at low temperature are reported. The results indicate that isotopic signatures of these components may be lost even at sub-ambient temperatures and thus have implications for the storage of cometary nucleus samples during return to Earth. Photochemically produced organics are made up of species with different stability to combustion including some of high volatility and others which are quite refractory. These materials are worthy of consideration as cometary analogues for use in preparing for the return of cometary nucleus samples. Their study could also help in the interpretation of the data which will eventually be gathered from the comet samples themselves.

51901 (ESA-SP–302, pp. 77-82) **Thermal conductivities and diffusivities of porous ice samples at low pressures and temperatures and possible modes of heat transfer in near surface layers of comets.** Spohn, T.; Seiferlin, K.; Benkhoff, J. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials*. 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Thermal conductivities of solid water ice, porous water ice and porous water ice/dust samples with porosities between 0.5 and 0.6 have been measured at a pressure of 1 Pa and at temperatures between 80 K and 170 K. The thermal conductivity was found to be 0.25 ± 0.05 W m^{-1} K^{-1} and to depend little on temperature and composition in the range of values considered. Thermal diffusivities and ratios between rates of matrix conductive heat transfer and heat transfer due to vapor flow have been estimated from the results of recent KOSI comet simulation experiments. The thermal diffusivities were between 10^{-7} and 10^{-8} m^2s^{-1} and the ratio between vapor and matrix conductive heat transfer was 10. Water vapor heat transfer is most likely less important if the near surface temperature of the Rosetta target comet is below 150 K. It is still possible, however, that vapors of more volatile phases contribute significantly to heat transfer.

51902 (ESA-SP–302, pp. 71-76) **Evolution of Ices and carbonaceous materials in the laboratory and in comets.** Bussoletti, E. (Istituto Universitario Navale, Naples (IT)); Strazzulla, G.; Colangeli, L. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials*. 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

We describe in this paper some of the main laboratory results concerning amorphous carbon production and organic ice irradiation. The experimental data are used to reproduce P/Halley's and other cometary IR spectra. The results indicate that the above mentioned materials appear to be among the best candidates to simulate the actual carbonaceous and organic components in comets.

51903 (ESA-SP–302, pp. 65-70) **Laboratory studies of cometary ice analogues.** Schmitt, B. (Laboratoire de Glaciologie et Geophysique de l'Environnement, 38 - St. Martin d'Heres (FR)); Espinasse, S.; Klinger, J.; Grim, R.J.A.; Greenberg, J.M. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Laboratory studies have been performed in order to simulate the physico-chemical processes that are likely to occur in the near surface layers of short and intermediate period comets. Pure H_2O ice as well as $CO:H_2O$, $CO_2:H_2O$, $CH_4:H_2O$, $CO:CO_2:H_2O$ and $NH_3:H_2O$ ice mixtures have been studied in the temperature range between 10 and 180 K. The evolution of the composition of ice mixtures, the crystallization of H_2O ice as well as the formation and decomposition of clathrate hydrate by different processes have been studied as a function of temperature and time. Using our results together with numerical modeling predictions are made about the survival of amorphous ice, CO, CO_2, CH_4 and NH_3 in the near surface layers of short period comets. The likeliness of finding clathrate and molecular hydrates is also discussed. It is proposed that the analytical methods developed here could be fruitfully adapted to the analysis of returned comet samples.

51904 (ESA-SP–302, pp. 55-64) **Physical processes in cometary ices inferred from laboratory studies.** Klinger, J. (Laboratoire de Glaciologie et de Geophysique de l'Environnement, 38 - St. Martin d'Heres (FR)). European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Based on recent laboratory studies, an overview is given of the properties of various ices and ice mixtures condensed at low temperatures and on their evolution during heating up to temperatures typical of the perihelion temperatures of short period comets. The kinetics of formation and of decomposition of clathrate hydrates and molecular hydrates is briefly outlined and the possibility of their occurrence in comet nuclei is discussed. Special attention is given to the thermal behavior of amorphous and fluffy icy material.

51905 (ESA-SP–302, pp. 197-200) **Some considerations on cohesive forces in sun-grazing comets.** Klinger, J. (Laboratoire de Glaciologie et de Geophysique de l'Environnement, 38 - St Martin d'Heres (FR)); Espinasse, S.; Schmitt, B. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Using a theory developed by Aggarwal and Oberbeck on tidal disruption of rigid bodies, an estimate is given for the internal cohesion of prominent sun-grazers. Considering the comet as a fluffy body, requirements are set on the tensile strength of the matrix material.

51906 (ESA-SP–302, pp. 191-196) **CO_2 depth profiles in cometary model substances of KOSI.** Hsiung, P. (Kernforschungsanlage Juelich G.m.b.H. (DE). Inst. fuer Chemie); Roessler, K. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

The CO_2 content of cometary analogs used in comet simulation experiments (KOSI-3) and (KOSI-4) was measured by gaschromatography. CO_2 depth profiles were determined after insolation in cm layers taken from the samples which orginally contained 14-15% frozen CO_2. These profiles show an upper layer completely depleted of the volatile component, while the deeper layers are not affected. Of special interest is a transition layer where the CO_2 content ranges from 0% to a value which is higher than that of the starting material (> 20%). This is interpreted as inward diffusion of CO_2 which can recondense in colder zones. In addition a correlation with the temperature profiles has been observed. The upper and lower layers show a rather constant but different temperature, while a very steep temperature gradient is found in the transition layer. The water-ice profile did not show any significant change with respect to the starting material.

51907 (ESA-SP–302, pp. 185-190) **A method of estimating temperature profiles and chemical differentiation in the near surface layers of porous comet nuclei - first results for comet P/Churyumov-Gerasimenko.** Espinasse, S. (Laboratoire de Glaciologie et de Geophysique de l'Environnement, St. Martin d'Heres (FR)); Klinger, J.; Ritz, C.; Schmidt, B. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

A method is presented for a quantitative estimation of thermal gradients and chemical differentiation in porous icy mixtures. This method has been applied to comet nuclei containing different volatile species with special attention given to subsurface layers. Heat conduction by the solid as well as heat and mass transport by the gas phase in the pore system are included. Based on recent laboratory studies, the influence of the crystallization of amorphous ice on the thermal behavior and the gas release is also considered. First results are presented for comet P/Churyumov-Gerasimenko.

51908 (ESA-SP–302, pp. 177-184) **Hot OH and CN - evidence for organic molecules close to the nucleus of comet Halley.** Clairemidi, J. (Observatoire de Besancon, 25 (FR)); Moreels, G. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

During the encounter session of Vega 2 with comet Halley on March 6, 1986, advantage was taken of the approach motion and of the resulting zoom effect to assemble the monochromatic charts produced by the three-channel spectrometer in composite images at selected wavelengths. Two jets are clearly apparent in most of the monochromatic images. The OH and CN emissions originating from the jets exhibit a pronounced peculiarity. The bands located at 309 and 388 nm show an excess of emission at 305 and 383 nm. The proposed mechanism, specific of the jets, is the photodissociation of one or several organic molecules of the type A-OH or B-CN which would release hot OH and CN when submitted to the solar UV flux. These organic molecules would be a component of the envelope of the CHON submicronic grains dragged by the gaseous jets. They provide an additional argument in favor of the similarity between cometary and interstellar matter.

51909 (ESA-SP–302, pp. 173-176) **Low velocity dust-dust collisions.** Blum, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg (DE)); Fechtig, H. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

An experimental setup has been developed to investigate collisional processes between protoplanetary/protocometary particles. The relative velocities of the order-of-mm-sized particles can be varied from $\approx$ 10cm/s to $\approx$ 10m/s. The first experiments were performed with fluffy agglomerates of particles each consisting of a glass core and an organic mantle (n-pentacosane) at relative velocities around 1.2m/s. No sticking of the collided agglomerates

was observed for relative amounts of n-pentacosane $\leq$17 weight%, whereas sticking was observed for relative amounts of organic material $\geq$22 weight%. The coagulation probability increases with increasing proportion of n-pentacosane.

51910 (ESA-SP–302, pp. 167-172) **Cometary bodies in the circumstellar disk around β Pictoris.** Beust, H. (Centre National de la Recherche Scientifique, 75 - Paris (FR). Inst. d'Astrophysique); Lagrange-Henri, A.M.; Vidal-Madjar, A.; Ferlet, R. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

The IRAS star β Pictoris is still the only one around which a disk made of both dust and gas has been detected. Spectroscopic observations of β Pic have revealed that some metallic absorption lines present redshifted additional components which strongly variate with time. This has been interpreted as the result of the infall of small evaporating cometary-like bodies toward the star. To improve this model, a theoretical description of such an event has been purchased. Numerical simulations of such infalling bodies have been able to reproduce quite faithfully the observed behaviour of some metallic ions, and we have explained the observed difference between these behaviours by means of radiation pressure. Some constraints on the orbits of the bodies have been deduced by through the simulations which should be related to a possible interpretation concerning β Pic's disk.

51911 (ESA-SP–302, pp. 129-140) **Simulation of radar and radiometer signals remote sensing cometary surface and subsurface structures.** Edenhofer, P. (Bochum Univ. (DE)); Noll, J. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Results of numerical calculations in the microwave range are presented concerned with the reflection, backscattering, and emission coefficient of simulated cometary surfaces as a function of signal frequency, angle of incidence, polarization, and surface roughness. The variations of the dielectric permittivity and loss tangent are estimated as to be expected for typical cometary surface conditions. The spatial resolution of potential Rosetta radar measurements is discussed. The subsurface penetration depth is given and a one-layer model is introduced. Preliminary results from experimental investigations are also presented simulating radar measurements probing a cometary surface in the frequency range 8 to 12.5 GHz. A special calibration technique using time domain transformation is applied to resolve the cometary reflection coefficient against background noise as to be expected in a simulation chamber. The results are discussed for different surface conditions and it is shown how specific surface and subsurface parameters can be determined.

51912 (ESA-SP–302, pp. 121-128) **Fracture mechanical aspects of dust emission processes from a model comet surface.** Ratke, L. (German Aerospace Establishment, Koeln (DE)); Kochan, H. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

High resolution video records taken from the virgin surface of a model comet in the small simulation chamber at the DLR showed a highly structured, rough surface during irradiation with artificial sun light. The observations demonstrated: 1. The surface itself is not calm, but partially in motion. Particles vibrate within the gas jet originating from sublimation of ice. After a certain time they lift off. 2. Particles which are obviously bonded to the surface loose after a certain time the bonds to their neighbours until they are free and accelerated by the gas jet. The observations show that the commonly considered view of dust emission processes by gravity force dominated particles has to be revised as well as the supposition of loosely deposited particles at fresh surfaces without any bonding. Model calculations of bond strength based on material parameters of ice show that these can be orders of magnitude higher than the gravity force. The mechanisms observed are analysed with fracture mechanical models, which are also applicable to the fracture of a cometary crust.

51913 (ESA-SP–302, pp. 205-208) **Gas diffusion in a cometary crust.** Koemle, N.I. (Graz Univ. (AT)); Steiner, G.; Banaszewskiewicz, M. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

It is generally believed that parts of the surface of a cometary nucleus are coated by non - volatile dust mantles, below which the cometary ice is buried. These dust mantles may be either extremely loose structures or they may exhibit some internal cohesion. In any case they are expected to be rather fluffy and porous, so that the vapour sublimated from the underlying ice is able to flow outward through the pores of such a mantle. We first give some critical comments regarding the validity of the Knudsen diffusion formula, which is generally used for the gas outflow through a cometary dust mantle at low densities, and subsequently present an alternative model for the gas flow through straight capillaries based on a Monte Carlo calculation. The results are compared with those given by the simple Knudsen diffusion formula, and the differences between these two approaches are discussed. Finally the relevance of the Monte Carlo model for the interpretation of recent KOSI experiments is pointed out.

51914 (ESA-SP–302, pp. 201-204) **Possible triggering of particle emission by mechanical stress and penetration of sublimating ice-dust-surfaces.** Kohl, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg (DE)); Gruen, E.; Baghul, M.; Koelzer, G.; Thiel, K.; Kochan, H. European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Laboratory simulation experiments have shown that sublimating surfaces of ice-dust mixtures are unstable against mechanical stress. This instability may be caused by a pressure gradient within the uppermost layers of the simulated cometary surface. Different kinds of stress, such as penetration, pressure change a low velocity particle impact were examined. In every case sudden increase of dust emission activity was observed. Evidence for real comets and possible consequences for the Rosetta mission are discussed.

51915 (ESA-SP–302, pp. 209-214) **Porosity and ice-dust mixtures in cometary particles.** Levasseur-Regourd, A.C. (Paris-6 Univ., 75 (FR)). European Space Agency, 75 - Paris (France). 1989. (CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* 246p. Order Number DE91709432. Source: NTIS (US Sales Only), PC A11/MF A01.

Numerous and consistent observations of light scattered by cometary dust allow to derive accurately the degree of linear polarization as a function of the phase angle, and the bulk geometric albedo. The derived values are typical of rough, pitted or aggregated textures. The decay with decreasing solar distance of interplanetary grains spiralling towards the Sun may be a clue to the thermal evolution of the coating which aggregates the cometary grains. The results indicate some break off of the clumps of grains, some loss of organic mantles by heating and the existence of various populations of dust particles.

51916 (IAE–4739-1) **Unified geometric theory of gravitation and electromagnetism: 4. Cosmological solutions.** Bryushinkin, S.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 8p. (In Russian). Order Number DE91603017. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Homogeneous isotropic cosmological solutions in a 5-D space with two timelike dimensions. In the model with a non-zero density of an energy-momentum tensor the Universe expansion splits into two phases: the exponential and the conventional Fridman-type one, each phase is characterized by its Hubble constant. The large

value of the quasar component flying apart exceeding the velocity of light. 7 refs.

51917 (LA-UR-90-3059) **Nonlinear pulsation masses.** Davis, C.G. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9005249-6: Confrontation between stellar pulsation and evolution, Bologna (Italy), 28-31 May 1990). Order Number DE91000364. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The advent of nonlinear pulsation theory really coincides with the development of the large computers after the second world war. Christy and Stobbie were the first to make use of finite difference techniques on computers to model the "bumps" observed in the classical Cepheid light and velocity curves, the so-called "Hertzsprung" sequence. Following this work a more sophisticated analysis of the light and velocity curves from the models was made by Simon and Davis using Fourier techniques. Recently a simpler amplitude equation formalism has been developed that helps explain this resonance mechanism. The determination of Population I Cepheid masses by nonlinear methods will be discussed. For the lower mass objects, such as RR Lyrae and BL Her. stars, we find general agreement using evolutionary masses and nonlinear pulsation theory. An apparent difficulty of nonlinear pulsation theory occurs in the understanding of "double" mode pulsation, which will also be discussed. Recent studies in nonlinear pulsation theory have dealt with the question of mode selection, period doubling and the trends towards chaotic behavior such as is observed in the transition from W Virginis to RV Tauri-like stars. 10 refs., 1 fig., 2 tabs.

51918 (LA-UR-90-3072) **Radioactive targets for nuclear astrophysics research at LANSCE.** Koehler, P.E.; O'Brien, H.A.; Gursky, J.C. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009161-1: 15. world conference of the International Nuclear Target Development Society: special high-purity materials and targets, Santa Fe, NM (USA), 10-14 Sep 1990). Order Number DE91000426. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

During the past few years we have made measurements of (n,p) and (n,α) cross sections on several radioactive nuclei of importance to nuclear astrophysics. The measurements were made at the Manuel Lujan, Jr., Neutron Scattering Center (LANSCE) from thermal neutron energy to approximately 100 keV. Successful measurements have been completed on the radioisotopes ^{7}Be, ^{22}Na and ^{36}Cl while preliminary data have been taken on targets of ^{54}Mn and ^{55}Fe. Similar measurements have also been made on the stable isotopes ^{14}N, ^{17}O and ^{35}Cl. We are currently assembling a 4π barium fluoride (BaF_2) detector which will allow us to expand our program to (n,γ) measurements. The (n,γ) (and in some cases future (n,p)) measurements will require targets with higher specific activity and greater chemical purity than we have so far been able to use. We discuss the fabrication techniques used for the samples produced so far, the requirements the future (n,γ) targets must meet and our current plans for producing them, and the physics motivations for the measurements.

51919 (PB-90-251224/XAB) **Solar-Geophysical Data Number 549, May 1990. Part 1 (Prompt Reports). Data for April, March 1990, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). May 1990. 165p. (SGD-549-PT-1). Source: NTIS, PC A08/MF A01.

See also PB-90-251232.

Contents: data for April 1990-(solar-terrestrial environment, IUWDS alert periods, solar activity indices, solar flares, solar radio emission, and stanford mean solar magnetic field); data for March 1990-(solar active regions, sudden ionospheric disturbances, Pioneer XII interplanetary magnetic field magnitudes, solar radio spectral observations, geomagnetic indices, and radio propagation indices); late data-(nancay interferometric chart Mar 90, geomagnetic activity indices Feb 90, sudden commencements Dec 89-Jan 90, Pioneer XII solar wind data 1989, and forbush decreases Mt. Washington 1954-1990).

51920 (PB-90-251232/XAB) **Solar-Geophysical Data Number 549, May 1990. Part 2 (Comprehensive reports). Data for November 1989 and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). May 1990. 102p. (SGD-549-PT-2). Source: NTIS, PC A06/MF A01.

See also PB-90-251224.

Contents: solar flares; solar radio bursts at fixed frequencies; interplanetary solar particles and plasma; solar x-ray radiation from GOES satellite graphs; mass ejections from the sun; active prominences and filaments.

51921 (PB-90-256330/XAB) **White Light Solar Corona: An Atlas of 1988 K-Coronameter Synoptic Charts, December 1987-January 1989. Technical note.** Sime, D.G.; Garcia, C.; Yasukawa, E.; Lundin, E. High Altitude Observatory, Boulder, CO (USA). Mar 1990. 87p. (NCAR/TN-346+STR). Source: NTIS, PC A05/MF A01.

See also PB-87-196382.

The synoptic observing project of the High Altitude Observatory's Coronal Dynamics Program began on 30 July 1980. The data obtained for it are gathered by the Mark-III K-coronameter located at the Mauna Loa Solar Observatory, Hawaii, and are published yearly in volumes of The White Light Solar Corona: An Atlas of K-Coronameter Synoptic Charts (Table 1). The data, in the form of synoptic charts, are extended at both the beginning and the end of each year to provide some overlap with the preceding and succeeding volumes. This is also necessary to provide a complete set of the data organized into Carrington rotations covering a specific time period, since the rotations do not coincide with the yearly calendar. Further observations are made at the limb, and west limb passage occurs 14 days after east limb passage. Thus, an entire rotation's data requires more than 28 days to collect. Together with the synoptic maps and polar synoptic maps, two additional sections designed to aid the user are included in the volume. As in previous Atlases, the Activity Report Summary for the year is given and the Mauna Loa Solar Observatory Calendar for 1988 (Table III) is also included. This is a list of days on which no coronal observations were achieved. These synoptic data should be regarded as a preliminary presentation in which corrections have not fully been made for the day-to-day variations and scattering of polarized light by the earth's atmosphere. Data from the east and west limbs are presented separately in the synoptic charts, as transient and evolutionary changes in the white light corona can substantially modify the distribution of coronal material over the 14 days between sequential limb passages.

51922 (PB-90-258799/XAB) **Solar-Geophysical Data Number 550, June 1990. Part 1 (Prompt Reports). Data for May, April 1990 and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Jun 1990. 151p. (SGD-550-PT-1). Source: NTIS, PC A08/MF A01.

See also PB-90-258807.

Contents: detailed index for 1989-1990; data for May 1990-solar-terrestrial environment, IUWDS alert periods (advance and worldwide), solar activity indices, solar flares, solar radio emission, stanford mean solar magnetic field; data for April 1990-solar active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic ray measurements by neutron monitor, geomagnetic indices; late data-geomagnetic indices-geomagnetic activity indices March 1990.

51923 (PB-90-258807/XAB) **Solar-Geophysical Data Number 550, June 1990. Part 2 (Comprehensive Reports). Data for December 1989 and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Jun 1990. 98p. (SGD-550-PT-2). Source: NTIS, PC A05/MF A01.

See also PB-90-258799.

Contents: detailed index for 1989-1990; data for December 1989-solar flares, solar radio bursts at fixed frequencies, interplanetary solar particles and plasma, solar x-ray radiation from GOES satellite, mass ejections from the sun, active prominences and filaments; miscellaneous data-Meudon Carte synoptique-Carrington rotations 1820-1821 September-October 1989, interplanetary solar plasma-IMP-8 solar wind July-November 1989.

51924 (PSC-8) **X-ray emission due to interaction of SN1987A ejecta with its progenitor's stellar-wind matter.** Masai, Kuniaki. Nagoya Univ. (Japan). Plasma Science Center. Jun

1990. 17p. Order Number DE91713050. Source: NTIS (US Sales Only), PC A03/MF A01.

The progenitor of the supernova 1987A, Sk-69 202 probably had lost a considerable amount of mass in its stellar wind in the past evolutionary track through a red supergiant to a blue supergiant. In about 10 years, the expanding ejecta of SN1987A will catch up to collide with the wind matter ejected in the red supergiant phase. Shocks due to the collision will heat up the ejecta and the wind matter to cause an enhancement of thermal X-ray emission lasting for several decades. We predict the X-ray light curve and the spectrum as well as the epoch of the enhancement intending to encourage future X-ray observations, which will give a clue for the study of such peculiar stellar evolution with a blueward transition as Sk-69 202. (author).

51925 (TRITA-EPP-90-04) **Complementary aspects on matter-antimatter boundary layers.** Lehnert, B. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics. May 1990. 31p. Order Number DE91603008. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This paper gives some complementary aspects on the problems of the matter-antimatter metagalaxy model and its cellular structure, as being proposed by Klein and Alfven. A previously outlined one-dimensional model of a magnetized matter-antimatter boundary layer is updated and extended, by introducing amended nuclear annihilation data, and by making improved approximations of the layer structure and its dependence on relevant parameters. The critical beta value obtained from this model leads to critical plasma densities which are not high enough to become reconcilable with a cellular matter-antimatter structure within the volume of a galaxy. Additional investigations are required on the questions whether the obtained beta limit would still apply to cells of the size of a galaxy, and whether large modification of this limit could result from further refinement of the theory and from the transition to a three-dimensional model. Attention is called to the wide area of further research on ambiplasma physics, and on a three-dimensional cell structure with associated problems of equilibrium and stability. In particular, the high-energy ambiplasma component has to be further analysed in terms of kinetic theory, on account of the large Larmor radii of the corresponding electrons and positrons.

51926 (UCRL-JC-104996) **Bragg crystal polarimeter for the Spectrum-X-Gamma mission.** Holley, J. (Lawrence Livermore National Lab., CA (USA)); Silver, E.; Ziock, K.P.; Novick, R.; Kaaret, P.; Weisskopf, M.; Elsner, R.; Beeman, J. Lawrence Livermore National Lab., CA (USA). 13 Aug 1990. 13p. Sponsored by U.S. DOE Defense Programs; National Aeronautics and Space Administration. DOE Contract W-7405-ENG-48. (CONF-900756-45: SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000256. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are designing a Bragg crystal polarimeter for the focal plane of the SODART telescope on the Spectrum-X-Gamma mission. A mosaic graphite crystal will be oriented at 45° to the optic axis of the telescope, thereby preferentially reflecting those x-rays which satisfy the Bragg condition and have electric vectors that are perpendicular to the plane defined by the incident and reflected photons. The reflected x-rays will be detected by an imaging proportional counter with the image providing direct x-ray aspect information. The crystal will be $\approx$50 μm thick to allow x-rays with energies $\geq$4 keV to be transmitted to a lithium block mounted below the graphite. The lithium is used to measure the polarization of these high energy x-rays by exploiting the polarization dependence of Thomson scattering. The development of thin mosaic graphite crystals is discussed and recent reflectivity, transmission, and uniformity measurements are presented. 8 refs., 11 figs., 1 tab.

51927 **Supernovae.** Petschek, A. (New Mexico Inst. of Mining and Technology, Socorro, NM (USA)). 293p. Springer-Verlag New York Inc., New York, NY (USA) (1990).

This book offers papers incorporating the latest results and understanding about supernovae, including SN1987A. There are several chapters reviewing all the radio through infrared, visible, and ultraviolet to X-rays and gamma-rays but also neutrinos. Other chapters deal with the classification of supernovae, depending on their spectra and light curves. Three chapters treat supernovae theory, including an idea of a fractal burning front and another on the behavior of neutron stars.

51928 **Adiabatic supernova expansion into the circumstellar medium.** Band, D.L. (Institute of Geophysics and Planetary Physics and Physics Dept., Lawrence Livermore National Lab., Livermore, CA (US)); Liang, E.P. pp. 69-72 of Supernova remnants and the interstellar medium. Roger, R.S.; Landecker, T.L. Cambridge University Press, New York, NY (USA) (1988). pp. 535 (CONF-8706201–: 101. International Astronomics Union colloquium on interaction of supernova remnants with the interstellar medium, Penticton (Canada), 8-12 Jun 1987).

The authors perform one dimensional numerical simulations with a Lagrangian hydrodynamics code of the adiabatic expansion of a supernova into the surrounding medium. The early expansion follows Chevalier's analytic self-similar solution until the reverse shock reaches the ejecta core. The authors follow the expansion as it evolves towards the adiabatic blast wave phase. Some memory of the earlier phases of expansion is retained in the interior even when the outer regions expand as a blast wave. They find the results are sensitive to the initial configuration of the ejecta and to the placement of gridpoints.

51929 **Models for x-ray emission from Tycho's remnant.** Smith, B.W. (Los Alamos National Lab., NM (USA)); Jones, E.M. pp. 133-136 of Supernova remnants and the interstellar medium. Roger, R.S.; Landecker, T.L. Cambridge University Press, New York, NY (USA) (1988). pp. 535 (CONF-8706201–: 101. International Astronomics Union colloquium on interaction of supernova remnants with the interstellar medium, Penticton (Canada), 8-12 Jun 1987).

The authors reexamine the x-ray emission from Tycho's remnant using results from hydrodynamic models computed with a detailed spherically symmetric code. The observed synchrotron radio contours appear to require a cloudy circumstellar medium. The authors explore the x-ray emission properties of similar models. They find that they tend to produce broad shells of x-ray emission that resemble the observed x-ray observations, but it has little similarity to the evolution of remnants in cloudy media dominated by thermal conduction. More work needs to be done to ensure that the spectrum as well as the x-ray map can be modeled with the same cloudy circumstellar medium, although we believe it will not be difficult to obtain as good as statistical agreement with the spectral data as other models have achieved.

51930 **Radio emission from young supernova remnants: Effects of an inhomogeneous circumstellar medium.** Dickel, J.R. (Illinois Univ., Urbana, IL (USA). Dept. of Astronomy); Eilek, J.A.; Jones, E.M. pp. 235-238 of Supernova remnants and the interstellar medium. Roger, R.S.; Landecker, T.L. Cambridge University Press, New York, NY (USA) (1988). pp. 535 (CONF-8706201–: 101. International Astronomics Union colloquium on interaction of supernova remnants with the interstellar medium, Penticton (Canada), 8-12 Jun 1987).

The evolution of young supernova remnants has been modeled using a 1-dimensional hydrodynamic code. Turbulent dynamo amplification of magnetic fields and both turbulent and shock acceleration of relativistic electrons have been included macroscopically to produce synchrotron radiation. The observed radio morphology cannot be reproduced by expansion into a homogeneous medium; it appears that many small cloudlets must be present in the circumstellar material.

51931 **Infrared spectroscopy and mapping of IC443.** Wright, G.S. (United Kingdom Infrared Telescope Unit, Hilo, HI (USA)); Longmore, A.J.; Graham, J.R. pp. 395-398 of Supernova remnants and the interstellar medium. Roger, R.S.; Landecker, T.L. Cambridge University Press, New York, NY (USA) (1988). pp. 535 (CONF-8706201–: 101. International Astronomics Union colloquium on interaction of supernova remnants with the interstellar medium, Penticton (Canada), 8-12 Jun 1987).

The authors present infrared (IR) spectroscopy and imaging of the supernova remnant IC443. [FeII] 1.644 μm, Brackett γ and H_2 1-0 S(1) were detected. The most striking feature of the spectra is the high [FeII] 1.644 μm/Brackett γ ratio, which is typically $\sim$ 30.

The authors argue that this ratio is due to shock excitation. Two maps of the remnant in the 1.644 μm [FeII] line are used to study the line excitation. The IR [FeII] line is a sensitive probe for regions of shocked gas which is especially useful where the extinction is high, or the shocks are too slow to excite optical lines.

51932 **IRAS observations of collisionally heated dust in Large Magellanic Cloud supernova remnants.** Graham, J.R. (Lawrence Berkeley Lab., CA (USA)); Evans, A.; Albinson, J.S.; Bode, M.F.; Meikle, W.P.S. pp. 383-386 of Supernova remnants and the interstellar medium. Roger, R.S.; Landecker, T.L. Cambridge University Press, New York, NY (USA) (1988). pp. 535 (CONF-8706201–: 101. International Astronomics Union colloquium on interaction of supernova remnants with the interstellar medium, Penticton (Canada), 8-12 Jun 1987).

IRAS additional observations show that luminous far-IR sources are associated with the Large Magellanic Cloud (LMC) supernova remnants N63A, N49, N49B, and N186D. Comparison of the IRAS and x-ray data shows that a substantial fraction of the IR emission from three of the SNRs can be accounted for by collisionally heated dust. The ratio of dust-grain cooling to total atomic cooling is $\sim$ 10 in x-ray emitting gas ($T \sim 10^6$ K). The authors show why dust cooling does not dominate, but probably speeds SNR evolution in an inhomogeneous interstellar medium.

51933 **Gravitational and dynamical instabilities of a decelerating plane-parallel slab of finite thickness.** Voit, G.M. (Center for Astrophysics and Space Astronomy, Univ. of Colorado, Boulder, CO (US)). pp. 509-512 of Supernova remnants and the interstellar medium. Roger, R.S.; Landecker, T.L. Cambridge University Press, New York, NY (USA) (1988). pp. 535 (CONF-8706201–: 101. International Astronomics Union colloquium on interaction of supernova remnants with the interstellar medium, Penticton (Canada), 8-12 Jun 1987).

In order to explore how supernova blast waves might catalyze star formation, the authors investigate the stability of a slab of decelerating gas of finite thickness. They examine the early work in the field by Elmegreen and Lada and Elmegreen and Elmegreen and demonstrate that it is flawed. Contrary to their claims, blast waves can indeed accelerate the rate of star formation in the interstellar medium. Also, the authors demonstrate that in an incompressible fluid, the symmetric and antisymmetric modes in the case of zero acceleration transform continuously into Rayleigh-Taylor and gravity-wave modes as acceleration grows more important.

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Refer also to citation(s) 51919, 51922, 52543, 52559

51934 (AD-A–223370/8/XAB) **Studies of ionospheric dynamics utilizing data from DMSP. Final report, 1 January 1987-31 December 1989.** Heelis, R.A.; Hairston, M.R. Texas Univ., Richardson, TX (USA). Center for Space Sciences. 22 Feb 1990. 44p. Contract F19628-87-K-0014. Source: NTIS, PC A03/MF A01.

This report covers efforts primarily devoted to the reduction of ion drift meter data from the DMSP satellite. This work has required the development of sophisticated algorithms to generate in-situ ion drift velocity data with respect to the spacecraft and the derivation of an electrostatic potential distribution along the spacecraft track. This initial effort has been directed toward satisfying the needs of mathematical models of the high-latitude convection pattern, with some effort devoted to the improvement of the formulations currently in use. This report discusses the rationale for the preparation of data bases of the ion drift velocity and derived parameters from the DMSP data. The function of this computer code is described in detail to allow other users to make use of its capabilities.

51935 (AD-A–223627/1/XAB) **Rem-wake measurements obtained from the ionospheric sounding rocket MAIMIK.** Svenes, K.R.; Troim, J.; Maehlum, B.N.; Friedrich, M.; Torkar, K.M. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1990. 13p. (GL-TR–90-0166). Source: NTIS, PC A03/MF A01.

Pub. in Planet Space Science, Vol. 38, No. 5, 653-663(1990).

Results of plasma measurements from the ionospheric sounding rocket MAIMIK are reported. Data obtained by high-resolution plasma probes show distinct classical wake signatures during the entire flight. That is, the electron temperature was enhanced behind the rocket in a region where both the electron and ion density were well below the ambient values. In addition, electron temperature enhancements were also detected in the ram (forward) direction on the downleg. The measurements are presented and discussed in relation to the prevailing ionospheric conditions.

51936 (AD-A–223660/2/XAB) **NASA radiation-belt models AP-8 and AE-8. Report for June-September 1989.** Jordan, C. Radex, Inc., Bedford, MA (USA). 30 Sep 1989. 26p. Contract F19628-89-C-0068. (SCIENTIFIC–1). Source: NTIS, PC A03/MF A01.

Empirical models AP-8 and AE-8 for the trapped protons and electrons in the Earth's radiation belts are currently available from NSSDC. These are the culmination of a series of models developed by J.I. Vette and colleagues. The initial models were begun in the mid-sixties with the most recent model, AE-8, being released in 1980. These models are based on data ranging from 1958 to 1970. They have been well documented by TREND, a group working under a contract with ESA, contains some information on this model. The only models which are still available from NSSDC are the most recent proton and electron models AP-8 and AE-8. This document contains a brief summary of the modeling efforts to date based on information from Lemaire, Spjeldvik, and Rothwell. Results from AE8MAX, results from the models previously used at GL (AE6MAX + AEI7HI), and results from code provided by NSSDC are compared.

51937 (AD-A–223685/9/XAB) **Feasibility study for D-region equatorial ionosphere research using VLF radio waves. Technical report, 1 May 1989-15 January 1990.** Hildebrand, V.E. IWG Corp., San Diego, CA (USA). 15 Jan 1990. 82p. Source: NTIS, PC A05/MF A01.

This research report establishes experiment feasibility and presents a plan to explore dynamic properties of the equatorial D-region ionosphere. The objective is to derive geophysical information on the lower ionosphere at nighttime in near equatorial regions through the use of a new VLF radiowave measurement method which uses ionosphere mode conversion. The measurement technique uses VLF signals, that when propagating at a range of azimuthal angles (typically 190 to 360 deg) through the equatorial region (about + or - 20 magnetic latitude), undergo marked mode conversion. The mode conversion, as predicted by theory and shown by measurement, is so strong that many modes become near equal in amplitude, even modes that when entering the equatorial zone are more than 30 dB below the dominant mode. Signals are strongly mode 1 on entering the mode conversion zone, thus converted modal components provide information on ionosphere parameters causing the mode conversion process. This process is shown to be highly sensitive to ionosphere parameters. Spaced receivers located just within the mode conversion zone will provide data from a small reflection region, even though the transmitter is far away. Theoretical models of VLF propagation, used in an iterative inversion process, infer the parameters of the ionosphere. Topics covered include; measurement concept, mode conversion theory and measurement, literature review, geophysics phenomena to explore, research goals, technical approach and experiment plan.

51938 (AD-A–223850/9/XAB) **Amplification of critical-velocity ionization by a pulsed neutral beam.** Lai, S.T.; McNeil, W.J.; Murad, E. Air Force Geophysics Lab., Hanscom AFB, MA (USA). May 1990. 5p. (GL-TR–90-0177). Source: NTIS, PC A01/MF A01.

Pub. in Geophysical Research Letters, Vol. 17, No. 6, 737-740(May 1990).

Numerical results of computer simulations on critical ionization velocity (CIV) discharges in pulsed neutral beams are presented. In a typical CIV scenario, neutral molecules as well as newly created ions are traveling across the ambient magnetic field. The ions slow down as they transfer kinetic energy to the electrons via plasma waves. For a single pulse of neutral gas, there is a finite contact time between the beam and the plasma; the contact time is governed by the length of the pulse and the velocity of neutrals. The injection of multiple pulsed neutral beam into a magnetized plasma has the advantage that succeeding pulses may extend the effective

contact time of a single pulse. Using the particle-in-cell method of computer simulations, we show a detailed time history of the CIV process as a result of the interplay between plasma (wave-particle) interactions and collisional (ionization, charge exchange) processes. It is found that ions slowing down and lagging behind the pulses can still contribute to electron heating. Simulation results show that CIV in a multiple pulsed beam is more efficient than that in a single continuous pulse.

51939 (LA-UR–90-2968) **Modeling of the quasi-steady magnetotail.** Birn, J. (Los Alamos National Lab., NM (USA)); Schindler, K. Los Alamos National Lab., NM (USA). [1989]. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8910462–1: Workshop on magnetosphere-ionosphere plasma models, Huntsville, AL (USA), 11-13 Oct 1989). Order Number DE91000444. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The three-dimensional theory of the quiet magnetotail is reviewed and updated. The most advanced formulation of the theory allows one to solve the magnetohydrodynamic (MHD) equations including field-aligned flow by reduction to a set of ordinary differential equations and an ordinary integral. These solutions represent lowest order solutions of an asymptotic expansion of the MHD equations for small electric field and weak time dependence. Applications to the magnetotail configuration are presented, which include the following properties in a self-consistent way: Flaring of the tail in y and z, associated with the presence of B_y and B_z; variation of plasma sheet and current sheet thickness with x and y, associated with variations of B_z; field-aligned currents at the boundary between plasma sheet and lobes with the signature of "region 1" currents, i.e., toward the Earth on the dawn side and away on the dusk side, associated with the decrease of the tail flaring with distance from the Earth; net cross-tail magnetic field. Particular steady models with field-aligned flow demonstrate the important role of the flow in allowing or producing configurations with a transition from a thick closed plasma sheet to a much thinner distant open current sheet and for the possibility of thick plasmoids propagating in near equilibrium through the thin distant current sheet.

51940 (TRITA-EPP–89-06) **Electric fields in the magnetosphere.** Faelthammar, C.G. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics. Dec 1989. 41p. (CONF-891182–: International conference on plasma physics, New Delhi (India), 22-28 Nov 1989). Order Number DE91604155. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The electric field plays an important role in the complex plasma system called the magnetosphere. In spite of this, direct measurement of this quantity are still scarce except in its lowest-altitude part, i.e. the ionosphere. The large scale ionospheric electric field has been determined from measurement on the ground and in low satellite orbit. For most of the magnetosphere, our concepts of the electric field have mostly been based on theoretical considerations and extrapolations of the ionspheric electric field. Direct, in situ, electric field measurements in the outer parts of the magnetosphere have been made only relatively recently. A few satellite missions. most recently the Viking mission, have extended the direct empirical knowledge so as to include major parts of the magnetosphere. These measurements have revealed a number of unexpected features. The actual electric field has been found to have unexpectedly strong space and time variations, which reflect the dynamic nature of the system. Examples are give of measured electric fields in the plasmasphere, the plasmasheet, the neutral sheet, the magnetotail, the flanks of the magnetosphere, the dayside magnetopause and the auroral acceleration region. (author).

51941 (TRITA-EPP–89-07) **Dynamic trapping of electrons in space plasmas.** Brenning, N.; Bohm, M.; Faelthammar, C.G. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics. Dec 1989. 36p. Order Number DE91604156. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The neutralization of positive space charge is studied in a case where heavy positive ions are added to a limited region of length L in a collisionfree magnetized plasma. It is found that electrons which become accelerated towards the positive space charge can only achieve a partial neutralization: they overshoot, and the positive region becomes surrounded by negative space charges which screen the electric field from the surroundings. The process is studied both analytically and by computer simulations with consistent results: large positive potentials ($U>>kT_e/e$) can be built up with respect to the surrounding plasma. In the process of growth, the potential maximum traps electrons in transit so that quasineutrality is maintained. The potential U is proportional to the ambient electron temperature and the square of the plasma density increase, but independent of both the ion injection rate and the length L. The process explains several features of the Porcupinge xenon beam injection experiment. It could also have importance for the electrodynamic coupling between plasmas of different densities, e.g. the injection of neutral clouds in the ionosphere of species that becomes rapidly photoionized, or penetration of dense plasma clouds from the solar wind into the magnetosphere. (31 refs.) (authors).

51942 (TRITA-EPP–89-08) **The plasma universe.** Faelthammar, C.G. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics. Dec 1989. 38p. (CONF-8912104–: 142. IAU symposium on basic plasma processes on the sun, Bangalore (India), 1-5 Dec 1989). Order Number DE91604157. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The term 'Plasma Universe', coined by Hannes Alfven, emphasices the fact that plasma phenomena discovered in the laboratory and in accessible regions of space must be important also in the rest of the universe, which consists almost entirely of matter in the plasma state. Relevant aspect of this concept will be discussed. They include the response of the plasma to electric currents, the support of magnetic-field aligned electric fields, violation of the frozen-field condition, rapid release of magnetically stored energy, acceleration of charged particles, chemical separation, and filamentary and cellular structures. (authors).

51943 (TRITA-EPP–90-03) **Potential drops supported by ion density cavities in the dynamic response of a plasma diode to an applied field.** Bohm, M.; Torven, S. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics. Jun 1990. 15p. Order Number DE91604158. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experiments have shown that an applied voltage drop may either be supported by a cathode sheath or by a quasi-linear variation over the plasma lasting for several electron transit times. In the latter case an ion density cavity existed initially. An analytical model and numerical simulations are used to show that a cavity gives rise to a quasi-linear potential variation for applied voltage drops below a certain critical value. For larger values the drop concentrates to a cathode sheath. The quasi-linear profile steepens to a double layer for large cavity depths. (authors).

51944 **Large scale density modifications: theory and observations.** Hansen, J.D. (Physics Department, University of California at Los Angeles, Los Angeles, CA (USA)); Morales, G.J.; Duncan, L.M.; Maggs, J.E.; Dimonte, G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 418-421 (1 Jul 1989). (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

A 2-dimensional transport code is used to investigate the self-consistent formation of large scale (several km) density depletions in the ionosphere due to HF heating under nighttime conditions. It is found that rotation of the absorption surface due to nonlinear refraction of ray trajectories near the reflection layer is an essential point in explaining the phenomena. Results obtained are in excellent agreement with observations made in the May 3-6, 1988 campaign at Areibo.

51945 **Coronal mass ejections and large geomagnetic storms.** Gosling, J.T. (Los Alamos National Lab., NM (USA)); Bame, S.J.; McComas, D.J.; Phillips, J.L. *Geophysical Research Letters (American Geophysical Union) (USA),* 17(7): 901-904 (Jun 1990).

Previous work indicates that coronal mass ejection (CME) events in the solar wind at 1 AU can be identified by the presence of a flux of counterstreaming solar wind halo electrons (above about 80 eV). Using this technique to identify CMEs in 1 AU plasma data, the authors find that most large geomagnetic storms during the interval surrounding the last solar maximum (Aug. 1978-Oct. 1982) were associated with Earth-passage of interplanetary disturbances

in which the Earth encountered both a shock and the CME driving the shock. However, only about one CME in six encountered by Earth was effective in causing a large geomagnetic storm. Slow CMEs which did not interact strongly with the ambient solar wind ahead were particularly ineffective in a geomagnetic sense.

51946 **The lower hybrid drift instability at the magnetopause.** Gary, S.P. (Los Alamos National Lab., NM (USA)); Sgro, A.G. *Geophysical Research Letters (American Geophysical Union) (USA)*, 17(7): 909-912 (Jun 1990).

When the interplanetary magnetic field is northward, wave-particle cross-field transport may contribute to solar wind-magnetosphere coupling. Such transport is studied here through the use of hybrid computer simulations (particle ions, fluid electrons with nonzero mass) carried out in the x-y plane of plasma with a density gradient in the x direction, no average flow speed, and a magnetic field B = B(x)$\hat{z}$. At early times, the lower hybrid drift instability grows on the plasma gradient. However, at times long compared to an ion gyroperiod, the fluctuations coalesce to longer wavelengths in the y-direction and nondiffusive density x-profiles emerge which exhibit plateaus and inclusions qualitatively similar to those observed by ISEE near the magnetopause. These results call into question critical assumptions of quasilinear theories of cross-field transport by this instability.

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Refer also to citation(s) 50549, 50648, 51200, 51205, 51206, 51264, 51265, 51285, 51451, 51452, 51453, 51455, 51456, 51457, 51458, 51466, 51467, 51470, 51471, 51474, 51475, 51565, 51569, 51605, 51609, 51610, 52042, 52073, 52077, 52127, 52271, 52353, 52354, 52378, 52404, 52407, 52408, 52410, 52415, 52441, 52444, 52445, 52446, 52448, 52449, 52450, 52451, 52453, 52455, 52517, 52559, 52582, 52589

51947 (AD-A-223702/2/XAB) **High-current-density thermionic cathodes and the generation of high-voltage electron beams. Final technical report, 1 September 1982-30 April 1989.** Herniter, M.E.; Lipscomb, G.; Pearce, K.D. Michigan Univ., Ann Arbor, MI (USA). Dept. of Electrical Engineering and Computer Science. 30 Apr 1989. 53p. Contract N00014-82-K-0448. Source: NTIS, PC A04/MF A01.

The project entitled High-Current-Density Thermionic Cathodes and High Voltage Electron Beams From Thermionic Cathodes is aimed at developing a thermionic cathode of high current density for use intense electron-beam generators. The emitting material under study is lanthanum hexaboride (LaB6). The project breaks down into 3 major parts: development of methods for heating LaB6 disks to the emission-temperature range of 1800°C; measurement of the emission-current distribution over the cathode surface and correlation with thermionic-emission theory; and design and testing of an electron-gun diode with an LaB6 cathode which would be a prototype for use in an intense beam generator.

51948 (CBPF-MO-001/89, pp. 133-149) **On the measurements of molecular similarity: a connection between quantum chemistry and artificial intelligence.** Carbo, R. (Girona Col.legi Univ. (Spain). Div. de Ciencies); Calabuig, B. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1988. (In Portuguese). (CONF-8809499–: 6. Latin American School on Theoretical Chemistry, Rio de Janeiro (Brazil), 11-17 Sep 1988). In *6. Latin American School on Theoretical Chemistry. v. 1.* 301p. Source: Available from the Library of the Comissao Nacional de Energia Nuclear, RJ, Brazil.

Molecular similarity measures within the quantum concept of density functions are described and analyzed. It is intended to show how artificial intelligence techniques can be used within the framework of quantum theory, in order to study and classify the molecular structures and their properties. (A.C.A.S).

51949 (CONF-900926–3) **Picosecond multiphoton ionization of atomic and molecular clusters.** Miller, J.C.; Smith, D.B. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international conference on multiphoton processes; Paris (France); 24-28 Sep 1990. Order Number DE91000641. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

High peak-power picosecond laser pulses have been used for the first time to effect nonresonant or resonant multiphoton ionization (MPI) of clusters generated in a supersonic nozzle expansion. The resulting ions are subsequently detected and characterized by time-of-flight mass spectroscopy. Specifically, we present results involving MPI of clusters of xenon and nitric oxide. Previous MPI studies of many molecular clusters using nanosecond lasers have not been successful in observing the parent ion, presumably due to fast dissociation channels. It is proposed that the present technique is a new and rather general ionization source for cluster studies which is complementary to electron impact but may, in addition, provide unique spectroscopic or dynamical information. 23 refs., 5 figs.

51950 (CONF-901116–10) **Photodetachment of metastable He^-.** Thompson, J.S. (Tennessee Univ., Knoxville, TN (USA). Dept. of Physics); Dellwo, J.; Pegg, D.J.; Compton, R.N.; Alton, G.D. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 11. international conference on the application of accelerators in research and industry; Denton, TX (USA); 5-8 Nov 1990. Order Number DE91000706. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A crossed-beams apparatus has been used to measure angular distributions and cross sections for photoelectron detachment from metastable He^-. Energy- and angle-resolved electron spectroscopy was used to investigate the spectral dependences of the angular distribution of the photoelectrons. The angular distributions along with photoelectron yield measurements were used to determine the cross sections for photodetachment of He^- (2^4P) via the energy resolved He(2^3P) and He(2^3S) exit channels. The precision of the cross section measurements was enhanced by exploiting the kinematic effects associated with detachment from a fast beam source. Calculated cross sections for the photodetachment of H^- were used to establish an absolute scale for the He^- cross section measurements.

51951 (CONF-9009261–1) **Newly appreciated roles for electrons in ion-atom collisions.** Sellin, I.A. (Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy). Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Workshop on fast ion collisions; Debrecen (Hungary); 17-19 Sep 1990. Order Number DE91000555. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Since the previous Debrecen workshop on High-Energy Ion-Atom Collisions there have been numerous experiments and substantial theoretical developments in the fields of fast ion-atom and ion-solid collisions concerned with explicating the previously largely underappreciated role of electrons as ionizing and exciting agents in such collisions. Examples to be discussed include the double electron ionization problem in He; transfer ionization by protons in He; double excitation in He; backward scattering of electrons in He; the role of electron-electron interaction in determining beta parameters for ELC; projectile K ionization by target electrons; electron spin exchange in transfer excitation; electron impact ionization in crystal channels; resonant coherent excitation in crystal channels; excitation and dielectronic recombination in crystal channels; resonant transfer and excitation; the similarity of recoil ion spectra observed in coincidence with electron capture vs. electron loss; and new research on ion-atom collisions at relativistic energies.

51952 (CONF-9009267–1) **Radiation interactions in high-pressure gases.** Christophorou, L.G. (Oak Ridge National Lab., TN (USA)). Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville, TN (USA). [1990]. 81p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Physical and chemical mechanisms in molecular radiation biology conference; Woods Hole, MA (USA); 3-7 Sep 1990. Order Number DE91000732. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This article is on basic radiation interaction processes in dense fluids and on interphase studies aiming at the interfacing of knowledge on radiation interaction processes in the gaseous and the

liquid state of matter. It is specifically focused on the effect of the density and nature of the medium on electron production in irradiated fluids and on the state, energy, transport, and attachment of slow excess electrons in dense fluids especially dielectric liquids which possess excess-electron conduction bands ($V_0 < 0$ eV). Studies over the past two decades have shown that the interactions of low-energy electrons with molecules embedded in dense media depend not only on the molecules themselves and their internal state of excitation, but also on the electron state and energy in – and the nature and density of – the medium in which the interactions occur.

51953 (DOE/ER/13720–3) **[Spectroscopic diagnostics of electron-atom collisions: Progress report].** Colorado Univ., Boulder, CO (USA). [1990]. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13720. Order Number DE91000981. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This research program was started in 1984, with an initial focus on developing a powerful new method for obtaining highly detailed information on resonance-line excitation, using Na as a first test case. Although part of the apparatus needed for the required two dye lasers was in place, we otherwise started with an "empty laboratory." This experiment was completed at the end of 1988, although continuing analysis and preparing publications continued to the end of 1989. Our original proposal, as well as the 1987 renewal proposal, described our intention to then adapt this apparatus to three types of electron-atom excitation experiments. These are: multiply differential cross sections for other resonance-lines such as Li, metastable state excitation cross sections, such as Ca 4^3P and 3^3D, resonances in the excitation of weakly-bound states. It is still our intention to study these three areas, so this proposal is largely a reiteration of our 1987 proposal. However, I will emphasize here why these are important and the rationale behind the order in which we propose to attack these three subjects. As will be described, the proposed order has evolved due to laser developments within the last several years.

51954 (DOE/ER/40333–T3) **Exotic atoms and leptonic conservations: Technical progress report, February 1, 1990–January 31, 1991.** Kunselman, R. Wyoming Univ., Laramie, WY (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40333. (COO–2197-122). Order Number DE91000636. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The major 1989 efforts have been on two aspects of experiments at TRIUMF. One effort was production of muonic hydrogen and muonic deuterium into a vacuum. We study rates relevant to muonic catalyzed fusion, and if there are found an adequate number of muons in the 2s state then we plan to measure precision energies. The second effort was to develop plans for kaonic atoms at the kaon factory. We also completed analyses from the experiments with pionic atoms at LAMPF.

51955 (GSI–90-33(prepr.)) **Correlated e^+e^- peaks observed in heavy-ion collisions.** Saiabura, P. (Frankfurt Univ. (Germany, F.R.)); Bethge, K.; Sakaguchi, K.; Stiebing, K.E.; Backe, H.; Cowan, T.E.; Greenberg, J.S.; Schweppe, J.; Schwalm, D.; Bokemeyer, H.; Folger, H. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 13p. Contract BMFT 06HD133I;BMFT 06OF113;DE-AC02-76ER03074;DE-AC03-76 Source: Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

Three very narrow e^+e^- sum-energy peaks around 610, 750, and 810 keV have been observed in U+Th as well as in U+Ta collisions at beam energies around the Coulomb barrier. As no processes involving conventional atomic and nuclear physics were found to describe their origin, the data were in particular confronted with the hypothesis that the lines are due to the two-body decay of neutral objects in an e^+e^- pair. Although the 810 keV sum-energy line observed in U+Th is consistent with the prompt two-body e^+e^- decay of a neutral object if created nearly at rest in the heavy-ion center-of-mass system, the other lines require at least a considerably more complicated scenario if they are to be explained in the context of a two-body decay. (orig.).

51956 (GSI–90-38(prepr.)) **Interchannel interactions in high-energetic radiationless transitions of neon-like ions.** Fritzsche, S. (Technische Univ., Dresden (German Democratic Republic). Inst. fuer Angewandte Kernphysik); Zschornack, G.; Musiol, G.; Soff, G. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 15p. Order Number DE91706314. Source: NTIS (US Sales Only), PC A03/MF A01.

Relativistic K-LL Auger transition rates in intermediate coupling including interchannel interactions are presented for nine ions in the neon-isoelectronic sequence up to uranium. For neutral neon a comparison with experimental data is given. We demonstrate for the first time, that intercontinuum interactions result in a remarkable redistribution of individual transition rates even in high-energetic transitions. For instance, channel mixing shifts the $K\text{-}L_1L_1$ rate by about 4% and the $K\text{-}L_3L_3$ ($J = 0$) rate by about 11% in neon-like uranium, while total Auger rates are almost not affected. (orig.).

51957 (INS–830) **Sensitivity of deeply bound pionic atoms on the neutron skin.** Toki, H. (Tokyo Metropolitan Univ. (Japan). Dept. of Physics); Hirenzaki, S.; Yamazaki, T. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jun 1990. 11p. Order Number DE91712983. Source: NTIS (US Sales Only), PC A03/MF A01.

Theoretical study is given to see how the properties of deeply bound pionic atoms depend on the neutron skin. With increased neutron skin, the strong isovector part of the pion-nucleus optical potential helps develop a repulsive bump at the nuclear surface which pushes further out the pionic wave function and decreases the binding energy. With further increase of the neutron skin, the repulsive potential in the central part is reduced and an inner component of the wave function develops in the nuclear interior, and ultimately a pion bound sate of broad width is formed in the deep interior $R_n - R_p \geq 0.35$ fm. (author).

51958 (LAFI–147) **Hydrogen atom in a strong uniform electric field.** Damburg, R.Ya. AN Latvijskoj SSR, Riga (USSR). Inst. Fiziki. 1989. 28p. Order Number DE91602806. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It has been shown that notwithstanding the separability of the Schroedinger equation for the Lo-Surdo$_s$tark (LS-S) problem for hydrogen, the quasistationary states cannot be always characterized by parabolic quantum numbers of n_1, n_2,m. It is a reason why any numerical procedure of the calculation of the LS-S parameters E_0 and Γ which ignores this circumstance can appear to be invalid for large values of n_1 and F and small ones of n_2 and m. Experimental data on the photoionization of atoms in the presence of an electric field in the vicinity of the Rydberg series limit E=0 are in an accord with theoretical predictions. 32 refs.; 6 figs.

51959 (LA-UR–90-3133) **Intensity dependent Thomson scattering and harmonic generation from free electrons.** Schappert, G.T. Los Alamos National Lab., NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900926–2: 5. international conference on multiphoton processes, Paris (France), 24-28 Sep 1990). Order Number DE91000236. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In the three sections of this paper we will discuss the electron motion in an intense laser field, the radiation produced by this motion, and finally some issues involved in experiments to observe the harmonics and their frequency shifts.

51960 (LA-UR–90-3210) **Measurement of the absolute cross section for multiphoton ionization of atomic hydrogen at 248 nm.** Kyrala, G.A.; Nichols, T.D. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900926–1: 5. international conference on multiphoton processes, Paris (France), 24-28 Sep 1990). Order Number DE91000222. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We present measurements of the absolute rates for multiphoton ionization of the ground state from atomic hydrogen by a linearly polarized, subpicosecond KrF laser pulse at a wavelength of 248 nm. A laser crossed atomic beam technique is used. The irradiance was varied from 3×10^{12} w/cm^2 to 2×10^{14} w/cm^2 and three above threshold ionization peaks were observed. The measured

rate for total electron production is less than predicted by the numerical and perturbation calculations, but significantly higher than calculated by the Reiss and Keldysh methods. 21 refs., 7 figs.

51961 (LBL–26455, pp. 51) **Heat-capacity measurements of submonolayer ^{4}He films adsorbed on sapphire.** Kenny, W.; Richards, P.L. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The authors have built a novel microcalorimeter for studies of the heat capacity of submonolayers and multilayers physisorbed on a variety of substrates. The authors have completed a series of measurements of the heat capacity of ^{4}He submonolayers adsorbed on the optically polished, chemically cleaned sapphire. This study is of practical importance to the operation of composite infrared bolometers that are similar in construction to the calorimeter. The temperature dependence of the heat capacity for three different coverages of ^{4}He has been measured. The heat capacity has a temperature-dependent component that is the same for all coverages investigated, and a temperature-independent component that increases with coverage. One interpretation is that the temperature-dependent component is due to the solidification of ^{4}He near impurities on the surface, and that the temperature-independent component is due to a dilute gas phase that occupies the rest of the surface. The sharp decreases in heat capacity above 3.3 K are due to desorption of ^{4}He from the calorimeter. Measurements of the heat capacity of ^{4}He submonolayers adsorbed on Ag films are currently under way. This investigation has already shown that ^{4}He submonolayers on Ag exist in a two-dimensional gas phase between 2.3 and 3.5K. The current series of measurements, which have been extended down to 1.8 K through improvements in the apparatus, will explore the expected deviations from the two-dimensional gas-phase behavior that arise due to either second-virial-coefficient corrections to the ideal-gas law or the formation of two-dimensional solid phases.

51962 (LUNFD6-NFFK–1001-1-30-1990) **Angular correlations and fragmentation in intermediate energy heavy ion collisions.** Kristiansson, Anders. Lund Univ. (Sweden). Dept. of Cosmic and Subatomic Physics. May 1990. 34p. Order Number DE91602812. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Intermediate energy heavy-ion collisions have been studied from 35 A MeV up to 94 A MeV at various accelerators. Angular correlations between light particles and detection of projectile- and target-fragments have been used to investigate the reaction mechanisms in this transition region between low- and high energy. An excess of correlations is observed in the particle-particle elastic scattering plane. This excess increases with particle mass and can be understood in terms of momentum conservation. The fragmentation measurements gives an indication that both energy and momentum transfer to the spectator volumes does occur. (author).

51963 (ORNL/FTR–3764) **[Physics and chemistry of van der Waals particles]: Foreign trip report, August 27, 1990–September 21, 1990.** Klots, C.E. Oak Ridge National Lab., TN (USA). 8 Oct 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000776. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Accounts are given of the two major international conferences on the physics and chemistry of small particles, commonly referred to as van der Waals particles. Details of special interest to Oak Ridge National Laboratory personnel are cited. Information exchanges at Freiburg and Paris are described.

51964 (UCRL-CR–106064) **K-shell and L-shell plasma spectroscopy experiments: Final technical report.** Charatis, G. (KMS Fusion, Inc., Ann Arbor, MI (USA)). Lawrence Livermore National Lab., CA (USA); KMS Fusion, Inc., Ann Arbor, MI (USA). Oct 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000950. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Detailed atomic level populations in high temperature and dense plasmas have become increasingly important in laser generated plasmas. Certain spectral line intensity ratios are density-dependent while others are temperature-dependent. Both can be used to extract information concerning population kinetics and ion level populations. In order to be useful these dependencies must be characterized by independent means. In laser produced plasmas this can be done via holographic interferometry for electron density determinations and via the slope of the H-like free-bound continuum of K-shell lines for electron temperature determinations. The characterization of density- and temperature-dependent L-shell lines can be accomplished in ionization balance experiments in which laser irradiance is varied on targets which contain both K-shell and L-shell emitters. The K-shell free-bound continua provide the local temperature determination while holographic interferometry yields density profile information, from which the temperature and density dependent L-shell lines can be characterized. This paper discusses these concepts.

51965 (UCRL-ID–104990) **Design and operation of the electron beam ion trap.** Vogel, D. Lawrence Livermore National Lab., CA (USA). 30 May 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000074. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the basic features and operating principles of the Electron Beam Ion Trap. The differences between EBIT and other sources of highly charged ions are outlined. Its features and operating parameters are discussed. The report also explains why certain design choices were necessary and the constraints involved in building an electron beam ion trap. EBIT's evaporation cooling system is described in detail. 13 refs., 8 figs.

51966 **High energy and heavy ion beams in materials analysis.** Tesmer, J.R. (Los Alamos National Lab., Los Alamos, NM (US)); Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. 290p. Materials Research Society, Pittsburgh, PA (USA) (1990). (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

There is an increasing availability of a wider variety of beams and energies to materials scientists - provided by modern small electrostatic accelerators and the accelerators formerly used for nuclear physics research. In addition, elastic recoil detection which uses both higher energies and heavy ions has not been well documented in any one place. The low energy arena of ion beam materials analysis is well known. To extend the applicability of these techniques, both nuclear theory and data must be carefully revisited. Progress in both these areas is described in these proceedings as well as the needs for future work.

51967 **Measured radiative lifetimes for H_2 and HD in the E,F $^1\Sigma_g^+$ electronic state.** Chander, D.W. (U.S. Dept. of Energy, Offices of Basic Energy Sciences, Div. of Chemical Sciences (US)); Thorne, L.R. pp. MF1 of Proceedings of the forty-first symposium on molecular spectroscopy. The Ohio State University, Columbus, OH (USA) (1986). pp. 166 (CONF-8606172–: 41. symposium on molecular spectroscopy, Columbus, OH (USA), 16-20 Jun 1986).

R86000539.

This paper discusses the use of tunable, pulsed ultraviolet laser radiation to prepare H_2 and HD in selected rovibronic levels of the E,F $^1\Sigma^+$ electronic state. This state is accessible from the ground state, X $^1\Sigma_g^{+g}$, by means of two-photon excitation. Subsequent absorption of near infrared laser radiation by molecules prepared in the E,F $^1\Sigma_g^+$ state produces ions that are detected by a time-of-flight mass spectrometer. Radiative lifetimes of individual rovibronic levels are determined by measuring the ion signal as a function of the time delay between the ultraviolet and near-infrared laser pulses. A decreasing exponential function is fit to the ion signal associated with a particular level to obtain its lifetime. The authors report that measured lifetimes are in good agreement with previously reported theoretical lifetimes.

51968 **Rotational analysis of some vibronic bands in the $^3A_u \leftarrow {}^1A_g$ transition of Glyoxal: Spin splittings in the lowest triplet state of the isolated molecule.** Spangler, L.H. (Los Alamos National Lab., NM (USA)); Pratt, D.W.; Birss, F.W. pp. TC2 of Proceedings of the forty-first symposium on molecular spectroscopy. The Ohio State University, Columbus, OH (USA) (1986). pp. 166 (CONF-8606172–: 41. symposium on molecular spectroscopy, Columbus, OH (USA), 16-20 Jun 1986).

R86000539.

This paper discusses a rotational analysis of three vibronic bands (0_0^0, 7_0^2, and 5_0^1) in the laser-induced phosphorescence spectrum of glyoxal (CHO-CHO) which has been performed. From this analysis the authors deduce the rotational, spin-rotation, and spin-spin (plus spin-orbit) constants of the lowest triplet state of the isolated molecule. ^3A_u Glyoxal has been shown to exist in nearly the same trans-planar (C_{2h}) configuration as the lowest excited singlet state. Both geometries are very similar to that of the ground state. The dynamic implications of these structural findings are discussed. The authors compare the spin splittings determined in this work with those previously measured in the condensed phase, using optically detected magnetic resonance methods.

51969 Laser-induced phosphorescence spectroscopy in supersonic jets: The lowest triplet states of glyoxal, methylglyoxal, and biacetyl. Spangler, L.H. (Los Alamos National Lab., NM (USA)); Pratt, D.W. pp. TC1 of Proceedings of the forty-first symposium on molecular spectroscopy. The Ohio State University, Columbus, OH (USA) (1986). pp. 166 (CONF-8606172–: 41. symposium on molecular spectroscopy, Columbus, OH (USA), 16-20 Jun 1986).

R86000539.

This paper reports the first structural study of the lowest triplet states of three α-dicarbonyls (glyoxal, methylglyoxal, and biacetyl) using the technique of laser-induced phosphorescence (LIP) spectroscopy in supersonic jets. The authors state that the 0_0^0 band is the strongest band in the LIP spectrum of glyoxal, but the $T_1 \leftarrow S_0$ transitions of methylglyoxal and biacetyl each exhibit strong progressions in the torsional vibrations of the methyl groups, showing that these molecules undergo a conformational change of excitation to the lowest triplet state. A Franck–Condon analysis of the methylglyoxal spectrum, with proper consideration for nuclear spin statistics, yields a methyl barrier of $V_3 = 115 \pm 5$ cm^{-1} in this state. This value has been confirmed by a direct measurement of the tunneling splitting of A and E torsional levels. The hindering potential in the lowest triplet state of methylglyoxal is substantially different from those in the ground ($V_3 = 269$ cm^{-1}) and first excited singlet ($V_3 = 190$ cm^{-1}) states. Possible reasons for these differences are discussed.

51970 Electronic structure of heavy-atom molecules. Pitzer, R.M. (Ohio State Univ., Columbus, OH (USA). Dept. of Chemistry); Winter, N.W. pp. RA6 of Proceedings of the forty-first symposium on molecular spectroscopy. The Ohio State University, Columbus, OH (USA) (1986). pp. 166 (CONF-8606172–: 41. symposium on molecular spectroscopy, Columbus, OH (USA), 16-20 Jun 1986).

R86000539.

This paper discusses the use of effective core potentials and spin-orbit operators derived from relativistic atomic calculations in treating the electronic structure of molecules containing heavy atoms. The authors present computer programs both to evaluate integrals of the spin-orbit operator over Gaussian atomic orbitals and to transform them to integrals over molecular orbitals for polyatomic molecules. Results are given.

51971 Infrared rotational spectrum of $\tilde{X}\ ^3B_1$ CH_2 around 400 cm^{-1}. Sears, T.J. (Brookhaven National Lab., Upton, NY (USA). Chemistry Dept.). pp. TE1 of Proceedings of the forty-first symposium on molecular spectroscopy. The Ohio State University, Columbus, OH (USA) (1986). pp. 166 DOE Contract AC02-76CH00016. (CONF-8606172–: 41. symposium on molecular spectroscopy, Columbus, OH (USA), 16-20 Jun 1986).

R86000539.

This paper discusses pure rotational transitions in the methylene radical that have been detected at infrared wavelengths. The radical was generated in a discharge in a dilute mixture of ketene (CH_2CO) in helium and the transitions detected at Doppler limited resolution by diode laser absorption. The author states that so far, only transitions in the ground vibrational level have been detected, however the signal to noise is such that similar rotational transitions in the (010) level should also be detectable. The rotational levels involved ($K_a = 3,4$) are much higher in energy than any previously observed and their positions will enable further refinement of the $CH_2\tilde{X}^3B_1$ potential function. The study also demonstrates the utility of long wavelength infrared laser spectroscopy for detecting rotational spectra of light molecules and transitions between high rotational levels of the CH radical have also been detected with extremely high signal/noise.

51972 Calculated proton-induced thick-target neutron and radionuclide yields for $E_p \leq 100$ MeV. Wilson, W.B. (Los Alamos National Lab., Los Alamos, NM (US)); Arthur, E.D.; Bozoian, M.; Perry, R.T.; Young, P.G. pp. 39-50 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

Earlier proton-induced thick-target yield calculations have been extended in proton energy range and to additional target elements, using the proton stopping cross section data of Anderson and Ziegler and cross sections modeled with the GNASH code. The targets described include Be, C, O, Ne, Al, Si, Fe, Co, Ni, Cu, W, Pb and Bi. Thick- target yields are presented for these thirteen targets, with most extending to 100 MeV.

51973 Hydrogen and deuterium profiling in polymers using light and heavy ion elastic recoil detection. Green, P.F. (Sandia National Lab., Albuquerque, NM (US)); Doyle, B.L. pp. 87-102 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

Silicon and helium elastic recoil detection (ERD) have been used to obtain concentration versus depth profiles of hydrogen (^1H) and deuterium (^2H) in polymers. Using helium ERD, a depth resolution of 100nm was achieved in polystyrene, whereas 30 nm was achieved using silicon ERD. Polymers are in general susceptible to radiation damage and precautions are necessary in order to minimize this. These precautions are addressed. When helium ERD is used to obtain the yield versus energy profile, the conversion of this profile to one of concentration versus depth is relatively straightforward since the scattering cross sections for collisions between helium and ^1H or ^2H nuclei are independent of energy over typical incident energy ranges (2.3 - 3.0 MeV) used in these studies. With the use of silicon ions, corrections for the energy dependence of the scattering cross section must also be made. A comparison of helium ERD measurements of diffusion in polymer systems is made with those obtained using other techniques.

51974 Calculated γ induced thick-target neutron and radionuclide yields for $E_\alpha \leq 50$ MeV. Bozoian, M. (Los Alamos National Lab., Los Alamos, NM (US)); Perry, R.T.; Wilson, W.B. pp. 51-60 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

Thick-target yields for αs incident on elements $4 \leq Z \leq 15$ and $Z = 17$ have been calculated using the α stopping data of Ziegler with radionuclide production cross sections calculated with the GNASH code. Comparisons are made of the calculated cross sections with sparse measured data. Radionuclide production yields are tabulated at 5, 10, 20, 30, 40 and 50 MeV.

51975 A comparison of long distance electron and energy transfer. Closs, G.L. (Chicago Univ., IL (USA). Dept. of Chemistry); Piotrowiak, P.; Miller, J.R. pp. 23-31 of Photochemical energy conversion. Norris, J.R.; Meisel, D. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). pp. 364 (CONF-880767–: 7. international conference on photochemical conversion and storage of solar energy, Evanston, IL (USA), 31 Jul - 5 aug 1988).

This paper compares intramolecular long distance electron transfer (ET) and triplet energy transfer (TT using two similar series of model compounds in which the donor and acceptor distance is varied in an identical way by employing common rigid spacer groups with identical stereochemical attachments in both series. It is found

that transfer rates in the two series are correlated in a quantitative way. The results support a simple model which views TT as a simultaneous two-electron two-site exchange. The model is discussed in terms of the corresponding HOMO and LUMO overlap integrals.

51976 **Modeling of femtosecond laser-plasma interactions: Unsafe at any speed.** Rosen, M.D. (Lawrence Livermore National Lab., CA (USA)). pp. 66 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The authors describe the sue of large hydrodynamic/atomic physics simulation codes to model the radiative yields of various Z targets irradiated by high power femtosecond pulses.

51977 **Simulations of intense laser beams interacting with gases and solids.** Olson, G.L. (Computational Physics Group, Los Alamos National Lab., Los Alamos, NM (US)). pp. 75 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The Los Alamos Bright Source Lasers (LABS I and II) are discussed. LABS I generates subpicosecond pulses of 5 eV photons with peak intensities of a few 10^{17} W/cm$_2$, while LABS II operates with shorter pulses at 4 eV and reaches intensities one order of magnitude higher. These lasers have been focused onto gas and solid targets. The purpose of this paper is to discuss numerical simulations of these experiments.

51978 **Multiphoton ionization rates for atomic hydrogen: Solutions of Schrodinger equation compared with model values.** LaGattuta, K.J. (Los Alamos National Lab., NM (USA)). pp. 79 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

Direct solutions of the time-dependent Schrodinger equation, for an electron moving in three spatial dimensions (3D), bound initially ($t \leq 0$) by Coulomb potential, and acted upon by an extrinsic oscillating electric field, have been described recently. The oscillating electric field models the effect of an incident laser beam on the initially bound electron. Such solutions being rather difficult to obtain, the region of laser parameter space (I_0, ω_0) and range of electron binding energies (E_B) which has been considered to-date is very limited, at least for real 3D Coulomb potentials. Consequently, the accuracy of the oft-cited KRF model photoionization rates is still generally open to question. The authors describe the results of calculations of photoionization rates for atomic hydrogen initially in its ground state, and acted upon by a laser with a linearly polarized electric field, and with a photon energy ω_0 = 5 eV. Experiments with such a laser, and for neutral hydrogen targets, are underway. Comparison of computed rates is made with the Reiss formula and with the cycle average field ionization rate. Neither of these model rates being satisfactory, two new formulas are proposed.

51979 **Spectral shifting of intense femtosecond pulses during strong field ionization and plasma recombination.** Downer, M.C. (Texas Univ., Austin, TX (USA). Dept. of Physics); Wood, W.M.; Banyai, W.M.; Trisnadi, J. pp. 12 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

Highly amplified femtosecond pulses permit the study of atomic ionization in superintense light fields on a time scale shorter than the escape time of electrons from the interaction region or the recombination of ionized species. Most recent studies of strong field femtosecond ionization have utilized photoelectron spectroscopy at low gas pressures ($\sim 10^{-7}$ torr). The authors utilize a complementary experimental method with unique capabilities, namely the spectral blue shift which is caused by the ultrafast refractive index decrease which occurs when a plasma is created within 1 or 20 optical cycles during the pulse. Accurate analysis of such blue shifts requires modelling based on ionization rates calculated from a Keldysh theory. Because of the ultrashort pulse duration (<90 fs.), Atomic collisions and plasma expansion play no role, compared to experiments with picosecond and longer pulses. Moreover, the authors have shown that in a sufficiently tight focus geometry, contributions from non-ionizing χ processes (e.g. white light continuum generation, self focusing), which cause both red and blue shifts, are suppressed relative to plasma generation effects. Thus detailed observation of blue shift provides a clean diagnostic of strong field ionization which complements photoelectron spectroscopy in testing theories of superintense laser-atom interactions.

51980 **Can optical lasers interact with atomic nuclei.** Weiss, M.S. (Lawrence Livermore National Lab., CA (USA). Physics Dept.). pp. 3 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The interaction of optical lasers with atomic nuclei through electron motion is calculated semiclassically and quantum mechanically. Experimental tests are proposed.

51981 **3D particle simulation on interaction of ultrashort laser pulse with solid density hydrogen plasma.** Nishihara, K. (Osaka Univ., Suita (Japan). Inst. of Laser Engineering); Yasui, H. pp. 99 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The interaction of very short laser pulses with matter has become an important field. If a pulse duration of a laser light is so short that no significant hydrodynamic expansion of a matter takes place, the electric field of a laser interacts directly with a solid density matter. The mean ion distance, $a \sim (3/4\pi n)^{1/3}$ is of the order of one angstrom at a solid density. The quivering distance of electrons oscillating at a laser frequency, $\delta x = eE_0 / m\omega_0^2$, exceeds the mean ion distance at a high intensity. In addition to that, the ion coupling coefficient, $\gamma = e\phi / KT = z^2 e^2 / aKT$, is of the order of one for such a high density plasma. This the oscillating electrons interact with many ions and electrons at the same time, because ions and electrons are also strongly correlated. The authors discuss how they have studied the femtosecond laser-target interaction by using the 3d two-component (electron and ion) particle code SCOPE, in which short range forces are computed by using a direct particle-particle summation over spatially localized forces and long-range forces by particle-in-cell method.

51982 **The status of SLC commissioning.** Atwood, W.B. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). pp. 32-39 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 DOE Contract AC03-76SF00515. (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the key issue in the arcs and final focus areas which is survey. The first attempt to thread the electron beam through some 19 columnators and many more magnetic elements in the final focus is presented.

51983 **Searching for existing nuclear data.** Tesmer, J.R. (Los Alamos National Lab., Los Alamos, NM (US)); Cokal, H.; Maggiore, C.J. pp. 197-202 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

As an example of finding existing data useful for high energy and heavy ion materials analysis the Nuclear Structure References of Brookhaven National Laboratory's National Nuclear Data Center

was searched. The search was limited to incident ions of mass ≤ 7 amu (excluding alphas) with energies under 100 MeV, and the target nuclei were limited to mass ≤ 30 amu. Ease of use, time necessary for retrieval as well as pertinence was explored. Examples of applicable data found during the search are presented.

51984 Overview of σ, ρ and dσ/dt in high energy proton-antiproton scattering. Cahn, R.N. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA (US)). pp. 108-114 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Recent results on the total cross section, real-to-imaginary ratio of the forward scattering amplitude, and the slope parameter are discussed. The ability of future Tevatron data to distinguish between alternative explanations of the large value of ρ measured by UA-4 is emphasized.

51985 Initial operation of a high-power quasi-optical gyrotron. Fliflet, A.W. (Long Pulse Electron Cyclotron Maser Section, Beam Physics Branch, Plasma Physics Div., U.S. Naval Research Lab., Washington, DC (US)); Hargreaves, T.A.; Manheimer, W.M.; Fischer, R.P.; Barsanti, M.L. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 306-312 (Jun 1990).

Results from the initial operating of a high-power quasi-optical gyrotron based on the 90-kV 50-A Varian VUW-8144 electron gun are reported. The output power and efficiency have been measured for a resonator mirror separation of 19.4 cm with a magnetic field of 4.95 T, corresponding to resonator output coupling of 1.9%, and for a resonator mirror separation of 21.4 cm with a magnetic field of 4.7 T, corresponding to a resonator output coupling of 3.1%. Operation was multimoded with 3–6 modes excited in the range of 125–130 GHz for the 4.95-T magnetic field. A peak efficiency of 15% at an output power of 161 kW was obtained for a gun voltage of 93 kV and a current of 12 A. A peak-output power of 364 kW at an efficiency of 10% was obtained at a voltage of 95.6 kV and 37.5 A.

51986 Operation of a large-orbit high-harmonic gyro-traveling-wave tube amplifier. Furuno, D.S. (Marietta ADTO, Rancho Bernardo, CA (US)); McDermott, B.D.; Kou, C.S.; Luhmann, N.C.; Vitello, P. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 313-320 (Jun 1990).

The high-harmonic gyro-traveling wave tube (gyro-TWT) is a high-power ({ >=} 1 kW) millimeter wave amplifier based on the synchronous interaction of a beam of large-orbit axis-encircling electrons with a high-order cylindrical waveguide mode. Since the interaction occurs at a high harmonic of the cyclotron frequency, the intense magnetic fields required for the conventional fundamental-mode gyro-TWT are not required. A proof-of-principle experiment designed to demonstrate the interaction of a 150-mA 350-keV electron beam with the TE_{81} ode of a cylindrical waveguide is described. Principal results include a small signal gain of 10 dB, an interaction bandwidth of 4.3 percent, and a saturated power transfer from electron beam to wave of 0.5 kW.

51987 Equilibrium and stability of free-running, phase-locked, mode-locked quasi-optical gyrotrons. Manheimer, W.M. (Physics Div., Naval Research Lab., Washington, DC (US)); Levush, B.; Antonsen, T.M. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 350-368 (Jun 1990).

Equilibria and stability (both single-mode and sideband) are calculated and contrasted for free-running, phase-locked, and mode-locked oscillator configurations in a quasi-optical gyrotron. The oscillator can be phase-locked by direct injection of radiation into the oscillator cavity. The equilibrium and stability properties are not greatly affected here at low injection power levels. Alternatively, the oscillator could be phase-locked by prebunching the beam. If the beam is prebunched, there are dramatic effects on both equilibrium and stability. The transverse efficiency can be considerably enhanced by prebunching the beam. This prebunching can be done in either a phase-locked (using an external RF source) or mode-locked (using the oscillator output) configuration. The stable locking bandwidth turns out to be about half the ω/Q linewidth of the mode.

51988 Submillimeter-wave harmonic gyrotron experiment. Spira-Hakkarainen, S. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Kreischer, K.E.; Temkin, R.J. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 334-342 (Jun 1990).

A theoretical and experimental investigation of the operation at submillimeter wavelengths of a harmonic gyrotron is reported. Using a waveguide cavity with an iris at the output end of the straight section, 14 different second-harmonic modes were observed with frequencies of 301–503 GHz, output powers of 1-22 kW, and a 12-MHz emission frequency bandwidth. The highest output power was 22 kW, with a total efficiency of 3.5% at 467 GHz, and an output power of 15 kW with a 6% efficiency was obtained at 417 GHz. Research was conducted using a 65–75 kV up to 10-A electron gun with 1–1.5 μs pulse-length and a 4-Hz repetition rate, which produced a helical electron beam in magnetic fields of up to 14 T. These results represent the first operation of a high-power harmonic gyrotron in the submillimeter region.

51989 Multimode simulations without particles in the quasi-optical gyrotron. Riyopoulos, S. (Applied Physics Div., Science Applications International Corp., McLean, VA (US)). *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 369-386 (Jun 1990).

A set of coupled nonlinear differential equations, involving the slow amplitude and phase variation for each mode, is used to simulate the multimode dynamics in the quasi-optical gyrotron. The interaction among various modes is mediated by coupling coefficients of known analytic dependence on the normalized current I, the interaction length μ, and the frequency detunings Δ_j corresponding to the competing frequencies ω_j. The equations include all the possible resonant combinations of up to four different frequencies, $\omega_l - \omega_j + \omega_k - \omega_i \simeq 0$, among a set of N participating modes, keeping terms up to fifth order in the wave amplitudes. The formalism is quite general and can be used to study mode competition, the existence of a final steady state and its stability, as well as its accessibility from given initial conditions. It is shown that when $\mu/\beta_\perp \gg 1$, μ can be eliminated as an independent parameter.

51990 A particle-in-cell simulation of a cyclic beam buncher. Peratt, A.L. (Los Alamos National Lab., NM (USA)); Snell, C.M.; Felber, F.S. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 636-631 (Jun 1990).

A relatively weak TE wave in a cylindrical cavity can efficiently bunch an intense electron beam when the phase velocity of the wave is matched to the beam cyclotron frequency. Fully electromagnetic, relativistic, 2-$\frac{1}{2}$-dimensional simulations illustrate the applicability of this bunching mechanism to high-power generators.

51991 Differential, partial cross sections for electron excitation of the sodium 3P state. Han, X.L. (Joint Institute for Laboratory Astrophysics, National Institute of Standards and Technology, Boulder, CO (USA)); Schinn, G.W.; Gallagher, A. *Physical Review, A (General Physics) (USA),* 42(3): 1245-1257 (1 Aug 1990).

Using a powerful laser-based experimental method, the cross section for electron excitation of Na(3S) atoms to the Na(3P) state has been decomposed into partial components with respect to changes in the spin and angular momentum of the atomic electron, and these partial cross sections are further reduced to their differential character with respect to the electron scattering angle. Partial, differential cross sections are reported for electron collision energies from threshold 2.1 to 3.6 eV, and compared to available calculations.

51992 Double excitation of He by fast ions. Giese, J.P. (Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN (USA)); Schulz, M.; Swenson, J.K.; Schoene, H.; Benhenni, M.; Varghese, S.L.; Vane, C.R.; Dittner, P.F.; Shafroth, S.M.; Datz, S. *Physical*

Review, A (General Physics) (USA), 42(3): 1231-1244 (1 Aug 1990). DOE Contract AC05-84OR21400.

Autoionization of He atoms following double excitation by electrons, protons, C^{Q+} (Q=4–6), and F^{Q+} (Q=7–9) ions has been studied. The electron-emission yields from the doubly excited $2s^2(^1S)$, $2s2p(^1P)$, and $2p^2(^1P)$ states were measured at the reduced projectile energy of 1.5 MeV/nucleon for observation angles between 10° and 60°. The results indicate excitation to the $2s^2(^1S)$ and $2p^2(^1D)$ states increases as approximately Q^3, while excitation to the $2s2p(^1P)$ state varies as approximately Q^2, where Q is the charge of the projectile. These charge dependences are significantly less than the Q^4 dependence expected in the independent-electron model, suggesting the interaction between the two target electrons is important in creating the doubly excited states.

51993 Semiclassical study of the collision of a highly excited Rydberg atom with the molecules HF and HCl. Kimura, M. (Argonne National Laboratory, Argonne, IL (USA)); Lane, N.F. *Physical Review, A (General Physics) (USA)*, 42(3): 1258-1266 (1 Aug 1990). DOE Contract W-31109-ENG-38.

The semiclassical impact-parameter method is applied to the processes of state changing and energy transfer in the collision of a highly excited Rydberg atom ($n \geq 20$) with the polar molecules HF and HCl. The relative motion of the molecule and atomic nucleus is taken to be rectilinear; the electron-molecule and ion core-molecule interactions are represented by cutoff dipole forms. Cross sections for transitions involving quantum numbers n and l of the atom and rotational quantum number j of the molecule are obtained for a range of collision energies and initial atomic and molecular states. Comparisons are made with the results of earlier classical studies and with the quantum-mechanical impulse approximation. Collision rates are calculated and compared with experimental values for l mixing and n and j changing. The agreement between experiment and theory is shown to be satisfactory, within the uncertainties of both the measurements and the theory. Cases of agreement and disagreement between various theories are examined. One finding of the present work is that the quantum-mechanical impulse approximation appears to significantly overestimate the values of various state-changing cross sections when the internal energy defect is small. The validity of the impulse approximation for collisions of Rydberg atoms with polar molecules is discussed.

51994 High-resolution photoelectron spectrometry of selected *ns'* and *nd'* autoionization resonances in Ar, Kr, and Xe. Wu, J.Z. (University of Central Florida, Orlando, Florida 32816 (USA)); Whitfield, S.B.; Caldwell, C.D.; Krause, M.O.; van der Meulen, P.; Fahlman, A. *Physical Review, A (General Physics) (USA)*, 42(3): 1350-1357 (1 Aug 1990). DOE Contract AC05-84OR21400.

Photoionization cross sections (σ) and photoelectron angular distribution parameters (β) across the (ns',nd') autoionization resonances for Ar, Kr, and Xe have been measured with photon resolution widths as low as 0.023 A by means of synchrotron-based photoelectron spectroscopy. The experimental results are compared with those obtained by other experimental techniques and theoretical results. The enhanced resolution allows a redetermination of the width of the ns' resonances.

51995 Large pressure-dependent cooperative shifts in multicolor odd-photon resonant atomic excitation. Payne, M.G. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6378 (USA)); Garrett, W.R. *Physical Review, A (General Physics) (USA)*, 42(3): 1434-1441 (1 Aug 1990). DOE Contract AC05-84OR21400.

We show that when three-photon excitation of a dipole-allowed transition is mediated by two laser beams at angular frequencies ω_{L1} and ω_{L2} that are crossed at an angle θ, large cooperative pressure-dependent shifts occur in the line shape for resonant excitation. When excitation of the state is by a $2\omega_{L1} \pm \omega_{L2}$ process and either $\theta \ll 1$ or $\omega_{L1} \gg \omega_{L2}$, the cooperative shift is large compared with the pressure-induced width of the line. For the $2\omega_{L1}+\omega_{L2}$ case the shift is toward higher excitation energy, while for $2\omega_{L1}-\omega_{L2}$ the shift is to lower excitation energies. In cases where the resonance can be reached by more than one pathway, differing only in the directions of propagation of the photons involved in the excitation, multiple peaks are predicted in the excitation line shape.

51996 Analytic solutions for three-state systems with overlapping pulses. Carroll, C.E. (Department of Physics, St. John Fisher College, Rochester, NY (USA)); Hioe, F.T. *Physical Review, A (General Physics) (USA)*, 42(3): 1522-1531 (1 Aug 1990). DOE Contract FG02-84ER13243.

Two classes of analytic solutions for three-state systems involving two overlapping laser pulses of different shapes, or of similar shapes but with their centers displaced, are presented. We find a remarkable connection between the order of arrival of the two overlapping pulses and the effectiveness of transfer from the ground state to the third state, and we find remarkable results for the maximum occupation probability of the intermediate state. The approach of these analytic solutions to the adiabatic-following process is also demonstrated.

51997 Fluctuations in fluorescence from an ensemble of two-level atoms pumped simultaneously by a coherent and a chaotic field. Vemuri, G. (School of Physics, Georgia Institute of Technology, Atlanta, GA (USA)); Agarwal, G.S. *Physical Review, A (General Physics) (USA)*, 42(3): 1687-1692 (1 Aug 1990).

We use a recently developed model for the interaction of a two-level atom with a coherent and a chaotic field of arbitrary bandwidth to study population fluctuations induced by the chaotic pump. We report numerical results for the fluctuations in the intensity of the fluorescence and their power spectra. We also give results for the effect of field fluctuations on the macroscopic polarization produced by the atoms. We show how detuning of the laser from the resonance frequency of the atoms affects the fluctuations in the fluorescence. The fluctuation behavior is quite sensitive to the correlation time of the chaotic field.

51998 *K*-shell vacancy production by direct Coulomb ionization in 47-MeV Ca^{17+}+Ar collisions. Heber, O. (Cyclotron Institute, Texas A&M University, College Station, Texas 77843 (USA)). *Physical Review, A (General Physics) (USA)*, 42(3): 1795-1798 (1 Aug 1990).

Calculations employing the independent-electron approximation suggest that direct Coulomb ionization is the dominant mechanism for Ar K-vacancy production by 47-MeV Ca^{17+}, rather than K-K vacancy sharing as proposed by Schlachter *et al.* [J. Phys. B 21, L291 (1988)]. Using electron-capture probabilities for zero impact parameter given by the classical-trajectory Monte Carlo model, good agreement with the experimental charge-state distribution for multielectron capture in coincidence with Ar and Ca K x rays is achieved.

51999 Analytic solutions for nonsingular Coulomb potentials. Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06269 (USA)). *Physical Review, A (General Physics) (USA)*, 42(3): 1809-1812 (1 Aug 1990).

A series of nonsingular Coulomb potentials is found that admits exact analytic solutions. The form of the potentials is $V=-Ze^2/(r+a)$ with specific choices for the cutoff parameter a, which does not have the troublesome singularity at r=0 but retains the long-range feature of the Coulomb interaction. Determination of the parameter a and construction of the analytic solutions are discussed in detail. Applications to laser-induced dressing of atomic states are considered.

52000 Calculation of rotational energy transfer rates for HD (v=1) in collisions with thermal HD. Brown, N.J. (Applied Science Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (USA)); Longuemare, M. *Journal of Chemical Physics (USA)*, 93(4): 2413-2417 (15 Aug 1990). DOE Contract AC03-76SF00098.

State resolved rotational energy transfer rates for HD+HD collisions have been computed using quasiclassical dynamics. One of the HD molecules is given an energy corresponding to v=1 and a specific rotational state, $J_1 \leq 6$. The other HD molecule is given a rotational–vibrational energy corresponding to an eigenstate of HD but selected according to a thermal distribution at 300 K. The translational energy is selected according to the appropriate thermal distribution at 300 K. The energy transfer is dominated by

translational–rotational energy exchange. The calculated rotational energy transfer rates are compared with the experiments of Chandler and Farrow. Modest agreement is achieved for $J_1 \leq 2$. Reasons for the lack of agreement are discussed.

52001 **A crossed-beam study of the state-resolved dynamics of CH($X\,^2\Pi$)+D_2. I. The inelastic scattering channel.** Macdonald, R.G. (Chemistry Division, Argonne National Laboratory, Argonne IL 60439 (USA)); Liu, K. *Journal of Chemical Physics (USA),* 93(4): 2431-2442 (15 Aug 1990). DOE Contract W-31109-ENG-38.

The state-to-state integral cross sections for the inelastic scattering of CH($X\,^2\Pi$) and D_2 to produce rotationally excited CH($X\,^2\Pi$) product have been measured in a crossed-beam apparatus by the laser-induced fluorescence method. Two types of measurements were performed: (1) the translational energy dependence of an individual quantum state of the product and (2) the state distribution of the products at fixed and well-defined translational energy. For the inelastic scattering channel, the cross sections gradually increased from a dynamical threshold to a broad maximum and then slowly decreased as the translational energy increases. Evidence for multiple-impact rotational rainbows was found and a possible frequency-locking phenomenon between the two receding rotors resulted. Moderate orbital alignment was observed except for the highest rotational levels of the product. By comparing and contrasting the kinematically similar system CH($X\,^2\Pi$)+He, the influence of a strongly attractive potential energy surface on the inelastic scattering of CH+D_2 was inferred. Combining the results of the inelastic scattering and the isotopic exchange channels (the following paper) provide an unprecedented look into the dynamics of collisions between CH($X\,^2\Pi$) and D_2.

52002 **A crossed-beam study of the state-resolved dynamics of CH($X\,^2\Pi$) + D_2. II. The isotopic exchange channel.** Macdonald, R.G. (Chemistry Division, Argonne National Laboratory, Argonne, IL 60439 (USA)); Liu, K. *Journal of Chemical Physics (USA),* 93(4): 2443-2459 (15 Aug 1990). DOE Contract W-31109-ENG-38.

The state-to-state integral cross sections for the isotopic exchange reaction of CH($X\,^2\Pi$) with D_2 to produce CD($X\,^2\Pi$) have been measured in a crossed-beam apparatus by the laser-induced fluorescence method. Two types of measurements were performed: (1) the translational energy dependence of an individual quantum state of the product and (2) the state distribution of the products at fixed and well-defined translational energy. To understand some of the finer details of the reaction dynamics similar experiments were also carried out on the reaction CD($X\,^2\Pi$) with H_2 to give CH($X\,^2\Pi$). For the isotopic exchange channel, the cross section decreased rapidly with increasing translational energy, signifying a complex formation reaction mechanism. The CD(CH) product rotational level distributions are substantially colder than a statistical expectation and are interpreted as the result of a multiple-impact collision between the receding products in the exit channel. A novel frequency-locking mechanism, similar to that proposed to understand the dynamics of inelastic collisions between CH and D_2 (the preceding paper), is suggested to explain anomalous peaks in the product rotational level distribution for the isotopic exchange channel. However, the fine-structure state distributions for the reactive process, which are very different from that for the inelastic channel, cannot be rationalized by conventional interpretation. Some basic concepts about fine-structure selectivity in chemical reactions have been developed. With these concepts, it is conjectured that the fine-structure state distributions of open-shell molecules arising from reactive encounters could provide a "fingerprint" of the electronic wave function at the transition state.

52003 **Gaussian-1 theory of molecular energies for second-row compounds.** Curtiss, L.A. (Chemical Technology Division/Materials Science Division, Argonne National Laboratory, Argonne, IL (USA)); Jones, C.; Trucks, G.W.; Raghavachari, K.; Pople, J.A. *Journal of Chemical Physics (USA),* 93(4): 2537-2545 (15 Aug 1990). DOE Contract W-31109-ENG-38.

The Gaussian-1 theoretical procedure is extended and tested on compounds containing second-row atoms (Na–Cl). This is a composite procedure based on *ab initio* molecular orbital theory, utilizing large basis sets (including diffuse-*sp*, double-*d*, and *f*-polarization functions) and treating electron correlation by Moller–Plesset perturbation theory and by quadratic configuration interaction. Total atomization energies for a set of 24 species agree with accurate experimental data to an accuracy of better than 3 kcal/mol in most cases, SO_2 being the notable exception. Similar agreement is achieved for ionization energies, electron affinities, and proton affinities. The method is used to assess experimental data for a number of other compounds having less accurate atomization energies.

52004 **Monte Carlo simulations of hydrophobic polyelectrolytes. Evidence for a structural transition in response to increasing chain ionization.** Hooper, H.H. (Chemical Engineering Department, University of California, Berkeley, CA (USA)); Beltran, S.; Sassi, A.P.; Blanch, H.W.; Prausnitz, J.M. *Journal of Chemical Physics (USA),* 93(4): 2715-2723 (15 Aug 1990). DOE Contract AC03-76SF00098.

Monte Carlo simulation has been used to study the configurational properties of a lattice-model isolated polyelectrolyte with attractive segment–segment interaction potentials. This model provides a simple representation of a hydrophobic polyelectrolyte. Configurational properties were investigated as a function of chain ionization, Debye screening length, and segment–segment potential. For chains with highly attractive segment–segment potentials (i.e., hydrophobic chains), large, global changes in polymer dimensions were observed with increasing ionization. The transformation from a collapsed chain at low ionization to an expanded chain at high ionization becomes increasingly sharp (i.e., occurs over a smaller range of ionization) with increasing chain hydrophobicity. The ionization-induced structural transitions for this model hydrophobic polyelectrolyte are analogous to pH-induced transitions seen in real polyelectrolytes and gels. These studies suggest a simple explanation for such transitions based on competing hydrophilic and hydrophobic interactions.

6404 Fluid Physics

Refer also to citation(s) 51391, 51429, 51976, 52445, 52452

52005 (CONF-9005183–, pp. 43-50) **Phenomenology, diagnostics, and non-LTE effects in plasma-particle interactions.** Shaw, C.B. Jr. (EG and G Idaho, Inc., Idaho Falls (USA)); Snyder, S.C.; Eddy, T.L. Argonne National Lab., IL (USA). [1990]. DOE Contract AC07-76ID01570. From 8. symposium on energy engineering sciences: micro/macro studies of multiphase media; Argonne, IL (USA); 9-11 May 1990. In *Proceedings of the eighth symposium on energy engineering sciences: Micro/macro studies of multiphase media.* 254p. Order Number DE90014844. Source: NTIS, PC A12/MF A01.

Two phenomena of plasma-particle interactions are reported: creation of comet-like plasma plumes downstream from each particle after initial heating, and failure of the particles (but not the comets) to follow fluctuations in the visible plasma. A diagnostic method to measure true gas temperature and flow fields in thermal plasmas by Doppler-shifted Rayleigh scattering is reported in detail. Evidence for departure of plasmas from local thermal equilibrium (LTE) is presented, and its significance briefly discussed. 9 refs., 7 figs.

52006 (LA-UR–90-3311) **Concepts in strong Langmuir turbulence theory.** DuBois, D.F.; Rose, H.A. Los Alamos National Lab., NM (USA). [1990]. 32p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9007136–4: 1990 summer workshop on nonlinear and chaotic phenomena in plasmas, solids, and fluids, Edmonton (Canada), 16-27 Jul 1990). Order Number DE91000208. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Some of the basic concepts of strong Langmuir turbulence (SLT) theory are reviewed. In SLT system, a major fraction of the turbulent energy is carried by local, time-dependent, nonlinear excitations called cavitons. Modulational instability, localization of Langmuir fields by density fluctuations, caviton nucleation, collapse, and burnout and caviton correlations are reviewed. Recent experimental evidence will be presented for SLT phenomena in the interaction of powerful HF waves with the ionosphere and in laser-plasma interaction experiments. 38 refs., 11 figs.

52007 (UCRL-CR–105052) **Simulation and theory of radial equilibrium of plasmoid propagation: Final report.** Campbell, M.M.; Clark, R.M.; Mostrom, M.A. Lawrence Livermore National Lab., CA (USA); Mission Research Corp., Albuquerque, NM (USA). Sep 1989. 65p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (MRC/ABQ-R–1208). Order Number DE91000803. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Cases simulating beam currents to about 29 MA were done. Significant noise reduction and code speed-up were achieved for these cases. The net current scaling observed at lower beam current ($I_{net} \sim I_{beam}^{1/2}$) continued to hold up well, as did the equilibrium itself. A slight deviation in the expected thickness and radial structure of the current layer was observed, however. A laminar flow model is developed that appears to give good agreement with the simulation results. Suggestions for future work are discussed briefly.

52008 **Models of intermittency in hydrodynamic turbulence.** Kraichnan, R.H. (303 Potrillo Drive, Los Alamos, NM (USA)). *Physical Review Letters (USA),* 65(5): 575-578 (30 Jul 1990). DOE Contract W-7405-ENG-36.

A heurisitic model for evolution of the probability distribution (PDF) of transverse velocity gradient s in incompressible Navier-Stokes turbulence is distilled from an analytical closure for Burgers turbulence. At all Reynolds number *scrR*, the evolved PDF is $\propto |s|^{-1/2} \exp(-\text{const} \times |s| / \langle s^2 \rangle^{1/2})$ for large $|s|$. The model suggests that skewness and flatnesses are asymptotically independent of *scrR*, and that cascade to smaller scales is not a fractal process. For Burgers dynamics, both simulations and the analytical closure give a PDF $\propto |\xi|^{-1} \exp(-\text{const} \times |\xi| / \langle \xi^2 \rangle^{1/2})$ for large negative velocity gradient ξ.

6450 High Energy Physics

Refer also to citation(s) 52037, 52169

52009 (DOE/ER/40141–8) **High Energy Physics Program at the University of Alabama: Annual report, April 1, 1990–September 30, 1990.** DiBitonto, D.D.; Busenitz, J.K.; Baksay, L. Alabama Univ., University, AL (USA). Dept. of Physics and Astronomy. Sep 1990. 95p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-84ER40141. Order Number DE91000929. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics: study of Z^0 decays; QCD; new particles; Higgs bosons; and forward hadron calorimeter system.

52010 (LBL–26455, pp. 58-59) **Localization of multivibrational excitations.** Wartak, M.S.; Yang, L.H.; Fong, C.Y.; Shen, Y.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The problem of localization in fermion systems has received a great deal of attention in the last two decades. However, the parallel behavior in the boson systems has rarely been discussed. In reality, multiple excitations can readily occur in a boson system; the appearance of localization of multiple excitations in a boson system is also not uncommon. The existence of local vibrational modes in a polyatomic molecule, for example, has recently stimulated a tremendous amount of interest. The possibility of observing localized multiple vibrational excitations in molecular liquids and solids is very intriguing. In weakly bonded molecular polymers or clusters, how well the multiple vibrational excitations are localized can be a subject of fundamental importance. In all these cases, it will be very interesting if it is possible to identify the physical mechanism that causes the localization. They have studied the localization of multivibrational states in the one-dimensional boson system with onsite random anharmonicity. By introducing site basis state (local representation), they were able, in the limit of $\Delta/\bar{\Lambda} << 1$, where Δ is the coupling interaction between the nearest neighbors and $\bar{\Lambda}$ is the average on site anharmonic energy, to reduce to problem to Anderson-like model for a one-dimensional electron system with diagonal disorder. Assuming a Cauchy distribution for onsite anharmonicity, they have calculated the degree of localization. It is shown that the degree of localization increases with the increase of randomness.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 51563, 51564, 51567, 51576, 51596, 51597, 51984, 52059, 52093, 52094, 52095, 52098, 52129, 52138, 52140, 52144, 52148, 52151, 52156, 52157, 52158, 52161, 52170, 52187

52011 (ANL-HEP-CP–90-49) **Initial data from the Soudan 2 experiment.** Allison, W.W.M. (Oxford Univ. (UK). Nuclear Physics Lab.); Barr, G.D.; Brooks, C.B.; Cobb, J.H.; Giles, R.H.; Perkins, D.H.; Shield, P.D.; Thomson, M.A.; Tupper, L.M.; West, N.; Alner, G.J.; Cockerill, D.J.A.; Edwards, V.W.; Garcia-Garcia, C.; Litchfield,.Argonne National Lab., IL (USA). High Energy Physics Div. May 1990. 22p. Sponsored by U.S. DOE Energy Research; University of Minnesota; State of Minnesota; U.K. Science and Engineering Research Council. DOE Contract W-31109-ENG-38. (CONF-900822–10: 25. IUPAP international conference on high energy physics, Singapore (Singapore), 2-8 Aug 1990). Order Number DE90017833. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Soudan 2 is an 1100-ton tracking calorimeter which is being constructed to search for nucleon decay. The detector consists of finely segmented iron instrumented with drift tubes, and records three spatial coordinates and dE/dx for every gas crossing. Excellent event-reconstruction capability, particle identification, and muon sign and direction determination give superior rejection of the neutrino background to nucleon decay in many modes. Predicted detector performance has been verified using cosmic rays tracks and a charged particle test beam calibration. The first 516 tons of Soudan 2 are now in steady operation, with completion planned for 1992. Initial data on neutrino interactions in the first 0.23 fiducial-kiloton-year exposure are described here, as are preliminary results of a search for GUT magnetic monopoles. Plans for studies with single and multiple cosmic-ray muon events, and with contained atmospheric neutrino interactions, are also presented. 7 refs., 6 figs.

52012 (CONF-8908131–7) **Pion double charge exchange scattering above the delta resonance.** Burleson, G.R. New Mexico State Univ., Las Cruces, NM (USA). Dept. of Physics. [1989]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract FG04-88ER40403. From 2. LAMPF workshop on pion-nucleus double charge exchange; Los Alamos, NM (USA); 9-11 Aug 1989. Order Number DE91000606. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Data are presented on pion-nucleus double-charge-exchange scattering at energies between 300 and 500 MeV, the highest energies measured so far, together with a review of results at lower energies. The small-angle excitation functions disagree with predictions based on a sex-quark cluster model and on an optical model consistent with single-charge-exchange scattering at these energies, but they are consistent with a distorted-wave calculation. Data on $f_{7/2}$-shell nuclei are in partial agreement with a two-amplitude model which is successful at lower energies. In order to achieve good understanding of this process at these energies, more work; both experimental and theoretical, is needed. 16 refs., 6 figs.

52013 (CONF-9005233–4) **Pion double charge exchange scattering above the delta resonance.** Burleson, G.R. New Mexico State Univ., Las Cruces, NM (USA). Dept. of Physics. [1990]. 15p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG04-88ER40403. From 2. international conference on medium- and high-energy physics; Taipei (Taiwan); 8-18 May 1990. Order Number DE91000607. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Data are presented on pion-nucleus double-charge-exchange scattering at energies between 300 and 500 MeV, the highest energies measured so far, together with a review of results at lower energies. The small-angle excitation functions disagree with predictions based on a six-quark cluster model and on an optical model consistent with single-charge-exchange scattering at these energies, but they are consistent with a distorted-wave calculation. Data on $f_{7/2}$-shell nuclei are in partial agreement with a two-amplitude model which is successful at lower energies. In order to achieve

good understanding of this process at these energies, more work, both experimental and theoretical, is needed. 16 refs., 6 figs.

52014 (DOE/ER/10713–10) **Study of electron-positron interactions: Progress report.** Abashian, A.; Gotow, K.; Philonen, L. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). 15 Sep 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-80ER10713. Order Number DE91000682. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

For the past seven years, this group has been interested in the study of tests of the Standard Model of Electroweak interactions. The program has centered about the AMY experiment which examines the nature of the final state products in electron-positron collisions in the center of mass energy range near 60 GeV. Results of these measurements have shown a remarkable consistency with the predictions of the minimal model of 3 quark and lepton generations and single charged and neutral intermediate bosons. No new particles or excited states have been observed nor has any evidence for departures in cross sections or angular asymmetries from expectations been observed. These conclusions have been even more firmly established by the higher energy results from the LEP and SLC colliders at center of mass energies of about 90 GeV. Our focus is shifting to the neutrino as a probe to electroweak interactions. The relative merit of attempting to observe neutrinos from point sources versus observing neutrinos generally is not easy to predict. The improved ability to interpret is offset by the probably episodic nature of the emission and irreproducibility of the results. In this phase of development, it is best to be sensitive to both sources of neutrinos. As a second phase of our program at Virginia Tech, we are studying the feasibility of detecting cosmic ray neutrinos in a proposed experiment which we have called NOVA. the results of the test setup will be instrumental in developing an optimum design. A third program we are involved in is the MEGA experiment at Los Alamos, an experiment to place a limit on the rate of muon decay to electron plus photon which is forbidden by the Standard Model.

52015 (FNAL/C–90/159-E) **QCD studies at the hadron colliders.** Flaugher, B.L. The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). 10 Aug 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-9006268–3: 10. international conference on physics in collision, Durham, NC (USA), 21-23 Jun 1990; E–741/CDF). Order Number DE91000831. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two hadron collider experiments are actively pursuing QCD jet analyses. They are CDF, with a $\sqrt{s}$ = 1800 GeV, and UA2, with a $\sqrt{s}$ = 630 GeV. Recent results from these collaborations are discussed. The inclusive jet spectrum, dijet mass and angular distribution are compared to QCD predictions and used to set limits on quark substructure. Data from both experiments are compared to the $O(\alpha_s^3)$ calculations for the inclusive jet cross section. Studies of 3-jet, 4-jet and 5-jet events are described. A limit is set on the cross section for double parton scattering from the UA2 4-jet analysis. The inclusive photon cross section has been measured by both CDF and UA2 and is compared to theoretical predictions. 13 refs., 17 figs., 1 tab.

52016 (FNAL/C–90/165-E) **Search for the top quark and other new particles at $p\bar{p}$ colliders.** Contreras, M. (Chicago Univ., IL (USA). Enrico Fermi Inst.). The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Aug 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-9006268–4: 10. international conference on physics in collision, Durham, NC (USA), 21-23 Jun 1990). Order Number DE91000894. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Results from searches for the top quark, supersymmetric particles, and new gauge bosons at the CERN and Fermilab proton-antiproton colliders are reviewed. 22 refs., 15 figs., 3 tabs.

52017 (FNAL/C–90/172-T) **Overview of parton distributions and the quantum chromodynamics (QCD) framework.** Tuni, Wu-Ki (Institute of Gas Technology, Chicago, IL (USA)). Fermi National Accelerator Lab., Batavia, IL (USA). Aug 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-9004112–5: Workshop on hadron structure functions and parton distributions, Batavia, IL (USA), 26-28 Apr 1990). Order Number DE91000363. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The perturbative QCD framework as the basis of the parton model is reviewed with emphasis on several issues pertinent to next-to-leading order (NLO) applications to a wide range of high energy processes. The current status of leading-order and NLO parton distributions is summarized and evaluated. Relevant issues and open questions for second-generation global analyses are discussed in order to provide an overview of topics to be covered by the Workshop. 15 refs., 6 figs., 1 tabs.

52018 (IS-M–653) **Signals for W boson compositeness from rare B decays.** Rizzo, T.G. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics). Ames Lab., IA (USA). [1990]. 1p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. (CONF-9006267–4: 1990 DPF summer study on high energy physics, Snowmass, CO (USA), 25 Jun - 13 jul 1990). Order Number DE91000083. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Chia has recently shown that deviations from the Standard Model (SM) value for the W boson anomalous magnetic moment ($\Delta\kappa$) may be observable via rare decays such as $B \rightarrow K^*\gamma$. This work is reviewed, extended, and updated below. 4 refs., 1 fig.

52019 (IS-T–1420) **Exclusive neutral strange particle production from double Pomeron exchange produced by proton-proton interactions at $\sqrt{s}$ = 62 GeV.** Skeens, J. Ames Lab., IA (USA). 21 Sep 1990. 167p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000609. Source: NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

Data are presented for the first time on exclusive Pomeron-Pomeron interactions which produce a neutral strange and neutral antistrange particle pair in a central system X. In this paper, the system, X, is identified as one of the following neutral combinations; $K_s^0K_s^0$, $K_s^0K^{\pm}\pi^{\mp}$, $\Lambda^0\bar{\Lambda}^0$, $\Lambda^0\bar{\Lambda}^{0*}$. These data were obtained in proton-proton collisions at $\sqrt{s}$ = 62 GeV at the CERN ISR. The triggering systems used to obtain these data are described, followed by a description of the data. The central system mass distributions are presented along with differential mass cross section estimates. A broad enhancement is seen in the $K_s^0K_s^0$ system at a mass of 1.2 GeV, and is likely to have the quantum numbers $J^{PC} = 0^{++}$. Total cross section estimates of 1.3 $\pm$ .64 μb in the $K_2^0K_s^0$ system, . 44 $\pm$ .14 μb in the $K_s^0K^{\pm}\pi^{\mp}$ system, .20 $\pm$ .14 μb in the $\Lambda^0\bar{\Lambda}^0$ system, and .13 $\pm$ .06 μb in the $\Lambda^0\bar{\Lambda}^{0*}$ system are obtained.

52020 (LA–11905-T) **A measurement of $\Delta\sigma_L$(np), the difference between neutron-proton total cross sections in pure longitudinal spin states.** Beddo, M.E. Los Alamos National Lab., NM (USA). Oct 1990. 184p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36 ;FG04-88ER40403. Order Number DE91000885. Source: NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

Thesis. Submitted to New Mexico State University, Las Cruces, NM.

A measurement off $\Delta\sigma_L$(np), the difference between neutron-proton total cross sections in pure longitudinal spin states, is described. The results will help determine the isospin-zero (I = 0) scattering amplitudes, which are not well known above laboratory energies of 500 MeV, whereas the isospin-one (I = 1) amplitudes are fairly well-determined to 1 GeV. Data points were taken at the Los Alamos Meson Physics Facility (LAMPF) at Los Alamos, New Mexico, for five neutron beam energies: 484, 568, 634,720 and 788 MeV; they are the first in this energy range. Polarized neutrons were produced by charge-exchange of polarized protons on a liquid deuterium target (LD_2). Large-volume neutron counters detected the neutrons that passed through a polarized proton target. The counters subtended a range of solid angles large enough to allow extrapolation of the scattered neutrons to 0°. Two modifications to the LAMPF accelerator system which were made for this work are described. They included a "beam buncher," which modified the normal rf-time structure of the proton beam and allowed for

the selection of peak-energy neutrons by time-of-flight means, and a computerized beam steering program, which reduced systematic effects due to beam motion at the LD_2 target. The experimental values of $\Delta\sigma_L$(np) are found to be consistent with other np data, including preliminary data from SIN and Saclay, but not with some results from Argonne which used a polarized proton beam and a polarized deuteron target. The I = 0 component was extracted from $\Delta\sigma_L$(np) using existing pp data (I = 1), with the unexpected result that $\Delta\sigma_L$(I = 0) was found to be essentially identical in shape to $\Delta\sigma_L$(I = 1). The significance of this is not yet understood.

52021 (LA-UR-90-2984) **Phenomenology of some rare and forbidden η-decays.** Herczeg, P. Los Alamos National Lab., NM (USA). [1990]. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9003177–2: International workshop on rare decays of light mesons, Gif-sur-Yvette (France), 29-30 Mar 1990). Order Number DE91000437. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We discuss the contribution from possible new physics to the decays $\eta \to \mu^+\mu^-$, $\eta \to e^+e^-$, $\eta \to \mu e$ and $\eta \to \pi\mu e$, and assess the sensitivities required for experimental studies of these decays to extend our knowledge about the new interactions. 61 refs.

52022 (LA-UR-90-3359) **Rare decays.** Sanders, G.H. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9006276–1: 14. international conference on neutrino physics and astrophysics, Cern (Switzerland), 10-15 Jun 1990). Order Number DE91000169. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Rare decay experiments have made significant advances in the last several years. Limits on lepton number violating decays of kaons have been tightened. Large samples of strangeness changing neutral current kaon decays have been collected. For several suppressed processes, discovery windows for new physics have been substantially narrowed. Opportunities for detecting direct CP-violation have been changed by the observation of a new background to one decay mode and the prospects of high statistics studies of another process. 23 refs., 14 figs., 2 tabs.

52023 (LBL–29347) **The meson spectrum between 1 and 2 GeV: Gluonic states and other exotica.** Chanowitz, M.S. Lawrence Berkeley Lab., CA (USA). 20 Jul 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900601–12: 12. PANIC international conference on particles and nuclei, Cambridge, MA (USA), 24-29 Jun 1990). Order Number DE91000243 Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Present understanding of the meson spectrum is reviewed, with special attention on the search for gluonic states. Experimental progress has resulted in several paradoxes indicating states outside the $\bar{q}q$ spectrum of the nonrelativistic quark model. 59 refs., 1 fig., 2 tabs.

52024 (LBL–29488) **Concept for an experiment on particle and jet production at midrapidity.** Harris, J.W. (Lawrence Berkeley Lab., CA (USA)); Bloomer, M.; Chase, S.I.; Christie, W.; Friedlander, E.; Greiner, D.; Gruhn, C.; Gyulassy, M.; Jacobs, P.; Naudet, C.; Nygren, D.; Odyniec, G.; Olson, D.; Poskanzer, A.; Rai, G.; Ritter, H.G.; Schroeder, L.SLawrence Berkeley Lab., CA (USA). Jul 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900772–5: 4. workshop on experiments and detectors for a relativistic heavy ion collider, Upton, NY (USA), 2-7 Jul 1990). Order Number DE91000190. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The concept for an experiment to study global event signatures of quark Gluon Plasma formation and to investigate the propagation of jets through strongly interacting matter at high density is presented. Both event-by-event and inclusive measurements of physical observables can be made at midrapidity over a large solid angle ($|\eta|<1$) with full azimuthal coverage ($\Delta\phi = 2\pi$) and azimuthal symmetry. The detection system consists of a vertex detector and time projection chamber (TPC) inside a solenoidal magnet for tracking, momentum analysis and particle identification; a time-of-flight system surrounding the TPC for particle identification at higher momenta; and electromagnetic and hadronic calorimetry to measure and trigger on jets and the transverse energy of events. 7 figs., 2 tabs.

52025 (MPI-PAE/Exp.El.–227) **Heavy quark charge asymmetries below the Z^0 resonance.** Kroha, H. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Jul 1990. 46p. (CONF-900822–: 25. IUPAP international conference on high energy physics, Singapore (Singapore), 2-8 Aug 1990). Source: Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.

The status of charge asymmetry measurements for charm and bottom quarks below the Z^0 resonance is reviewed. An up-to-date compilation including the latest results is given. The combined charge asymmetry measurements are used to determine world average values for the weak neutral current couplings of the heavy quarks and to set limits on flavour oscillations in the neutral B π.eson system and on a possible common substructure of electrons and heavy quarks. The results for the axial-vector couplings of c and b quarks are a_c=+(0.98±0.16) and a_b=-(0.61±0.12), respectively, without taking B^0anti B^0 mixing into account. The sensitivity of the combined b asymmetry measurements for B^0anti B^0 oscillations has increased considerably leading to the result χ_l=0.171±0.065 for the mixing parameter. This value combined with measurements from like-sign dilepton production gives the first experimental confirmation for non-zero $B_s{}^0$ mixing, at a confidence level of more than 95%. Lower limits on the compositeness scale for electron and heavy quark contact interactions were obtained in the 1-3 TeV range (at 95% C.L.). (orig.).

52026 (PHE–86-13, pp. 334-340) **Electroweak precision measurements and radiative corrections at European Large Electron-Positron Storage rings (LEP)/Stanford linear collider (SLC).** Riemann, T. (Joint Inst. for Nuclear Research, Dubna (USSR)); Bardin, D.Yu.; Fedorenko, O.M. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

This not gives a motivation to do the programme 'ANALYTIC BREMSSTRAHLUNG INTEGRATION' and contains compact expressions for $e^+e^- \to \mu^+\mu^-(\gamma)$ and numerical results for total cross sections σ_{tot}, forward-backward asymmetry (A_{FB}), $d\sigma/d\cos\Theta$. (author).

52027 (SLAC-PUB–5115) **A search for new particles in Z decay.** Innes, W. Mark II Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Nov 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-890903–14: International Europhysics conference on high-energy physics, Madrid (Spain), 6-14 Sep 1989). Order Number DE91000460. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have searched 310 hadronic Z decays for evidence of new quarks and leptons. We set lower mass limits of 40.7 GeV/c^2 for top, 45 GeV/c^2 for bottom prime, and 42.4 GeV/c^2 for a heavy neutral lepton assuming their decays are predominantly via the charged current. Limits are also set for other decay modes and for mixtures of decay modes. 10 refs., 10 figs.

52028 **Proceedings of the VIIth International workshop on photon-photon.** Courau, A. (Lab. de l'Accelerateur Lineaire, Orsay Cedex (FR)); Kessler, P. 485p. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). (CONF-8604238–: 7. international workshop on photon-photon collisions, Paris (France), 1-5 Apr 1986).

Topics covered in this book include: Applications of amplitude factorization to double gamma production of vector meson pairs; Experimental results on jets; and Four-lepton production in photon-photon collisions.

52029 **Theoretical implications of the W-Z mass difference and the capabilities of the D0 detector in measuring it.** Raja, R. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 3-29 of

Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The authors examine the phenomenology of the W-Z mass difference as a function of the top quark mass and the Higgs mass. A detailed analysis is presented on how well the mass difference is measurable using the D0 detector at Fermilab. The authors show that the effective mass distribution of the Z^0 is not a Breit-Wigner at the Tevatron and present techniques developed for the D0 detector simulation that can be used to reduce the systematic errors in measuring the W-Z mass difference. Scenarios are presented for the integrated luminosities of 10 pb^{-1} and 100 pb^{-1} at the Tevatron. It is shown that the Tevatron is competitive with LEP II for integrated luminosities of 100 pb^{-1} in attainable precisions in this measurement. These considerations argue strongly for the pp option in the Tevatron upgrade program.

52030 W boson production in $\bar{p}p$ collisions at square root of s = 1.8 TeV. Proudfoot, J. (High Energy Physics Div., Argonne National Lab., Argonne, IL (US)). pp. 72-82 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 DOE Contract W-31-109-ENG-38. (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

This paper reports how the cross section for the production and subsequent decay of the W intermediate Vector boson to electron and neutrino has been measured in square root s = 1.8 TeV $\bar{p}p$ collisions using the CDF Collider Detector at Fermilab. For this measurement, W events were identified from the large missing transverse energy associated with the unseen neutrino and an electromagnetic cluster passing rather loose electron criteria. 22 events passing the selection missing transverse energy greater than 25 GeV and electron transverse energy greater than 15 GeV were observed in a sample of 25nb^{-1} yielding a $\sigma \cdot B = 2.6 \pm 0.6 \pm 0.5$nb. This result agrees well with a parallel analysis based primarily on the identification of isolated electrons and is in excellent agreement with theoretical predictions.

52031 Resonance production in photon-photon collisions. Shen, B.C. (Univ. of California, Riverside, CA (US)). pp. 3-24 of Proceedings of the VIIth international workshop on photon-photon. Courau, A.; Kessler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 485 (CONF-8604238–: 7. international workshop on photon-photon collisions, Paris (France), 1-5 Apr 1986).

A large number of $\gamma\gamma$ width measurements have been reported. The authors review the present status of pseudoscalar and tensor mesons. The world averages of the $\gamma\gamma$ width measurements are used to obtain the SU(3) mixing angles, and to determine the gluon contents. The experimental situation of scalar mesons is discussed. The measured limits on the $\gamma\gamma$ widths of various higher mass states are reviewed. The overall experimental situation is summarized.

52032 Minimum bias physics at square root s 1.8 TeV. Para, A. pp. 131-156 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Charged particles production at center- of-mass energies ($\sqrt{s}$) of 630 and 1800 GeV is studied using the Collider Detector (CDF) at Fermilab. Inclusive transverse momentum and pseudorapidity distributions are compared with low energy measurements and with theoretical models. Preliminary results on the inclusive strange particle and short range correlations are presented.

52033 $Z^0 \rightarrow N_4\bar{\nu} \rightarrow$ monojet. Rhie, S.H. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). pp. 111-115 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 DOE Contract AC03-76SF00515. (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses fourth-generation neutrinos that can be produced from on-shell Z^0 decays at the SLC or LEP. The author refers to neutrinos as heavy or light depending on whether the mass is larger or smaller than half of the mass of the Z^0. Let N denote the heavy neutrino.

52034 Evidence for the decay $\tau^- \rightarrow \pi^- \eta \nu_\tau$. Repond, J. (Argonne National Lab., Argonne, IL (US)). pp. 152-158 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the High Resolution Spectrometer collaboration that has searched for undetected decay channels of the τ-lepton. In particular, as the classification of one-prong decays indicates a higher rate than expected for the one-charged plus multiple-neutral channel, the author has searched for η-meson production in one-prong τ-decays. The analysis that gave evidence for the decay $\tau^- \rightarrow \pi^- \eta \nu_\tau$ is outlined. The author discusses the checks that have been done, including the background from hadronic- and two-photon events, and the probability of missing photons.

52035 Limits on fourth-generation neutrino masses and majoron emission from a double beta decay search. Caldwell, D.O. (Physics Dept., Univ. of California, Santa Barbara, CA (US)); Eisberg, R.M.; Grumm, D.; Witherell, S.; Goulding, F.W.; Smith, A.R. pp. 104-110 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses a low-energy process and the limits it sets on the mass of a fourth-generation Majorana neutrino as a function of its coupling to a first generation neutrino. The authors offer remarks on whether a particular experiment confirmed the reported possible observation of $\beta\beta_{0\nu}$ induced by majoron emission.

52036 A status report on the SLC program. Prescott, C.Y. (Stanford Univ., CA (USA)). pp. 118-137 of Test of electroweak theories: Polarized processes and other phenomena. Lynn, B.W.; Verzegnassi, C. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 461 (CONF-8506204–: Workshop on tests of electroweak theories, polarized processes and other phenomena, Trieste (Italy), 10-12 Jun 1985).

This paper presents status report on the progress of the SLC machine and two detectors.

52037 Experimental status of the N→Δ transition. Papanicolas, C.N. (Univ. of Illinois at Urbana-Champaign, Dept. of Physics and Nuclear Physics Lab., Urbana, IL (US)). pp. 235-255 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

The resonant quadrupole excitation of the Δ^+ (1232) can provide a sensitive observable needed to quide QCD inspired hadron phenomenology. The available experimental evidence is reviewed in the light of the recent extensive theoretical studies of this issue. The limitation of the available data are carefully examined in order to provide guidance to future measurements. The authors conclude by suggesting a novel approach in which the N→Δ transition is simultaneously studied in both the $(\vec{e}, e'\gamma)$ and $(\vec{e}, e'\pi^o)$ channels.

52038 Inclusive central jets at the Tevatron $\bar{p}p$ collider. Garfinkel, A.F. (Purdue Univ., West Lafayette, IN (US)). pp. 202-216 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

A measurement of the central inclusive jet cross section at square root s = 1.8 TeV using the CDF detector at the Tevatron $\bar{p}p$ Collider is presented. Comparisons are made to QCD calculations as well as to lower energy collider data.

52039 Jet fragmentation properties at CDF. Hubbard, B. (Lawrence Berkeley Lab., Berkeley, CA (US)). pp. 262-272 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Fragmentation properties of centrally produced jets at CDF have been studied. The rapidity (Y) distribution of charged particles to the jet axis is presented. The mean charged multiplicity in the jet core (at rapidities above 2) is seen to rise with increasing di-jet invariant mass (M_{JJ}), from 3 at M_{JJ} = 200 GeV. This is in agreement with expectations and follows the trend of previous experimental results.

52040 Status of Brookhaven rare kaon decay experiments. Cousins, R.D. (Physics Dept., Univ. of California, Los Angeles, CA (US)). pp. 283-290 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper summarizes the goals and status of the four rare kaon decay experiments at Brookhaven National Laboratory (BNL). The author describes other experiments and focuses on their status. Physics motivation and background calculations are presented.

52041 Radiative corrections in $SU_2 \times U_1$: LEP/SLC. Lynn, B.W. (Stanford Univ., CA (USA)); Peskin, M.E.; Stuart, R.G. pp. 213-298 of Test of electroweak theories: Polarized processes and other phenomena. Lynn, B.W.; Verzegnassi, C. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 461 (CONF-8506204–: Workshop on tests of electroweak theories, polarized processes and other phenomena, Trieste (Italy), 10-12 Jun 1985).

This paper shows the sensitivity of various experimental measurements to one-loop radiative corrections in $SU_2 \times U_1$. Models considered are the standard GSW model as well as extensions of it which include extra quarks and leptons, SUSY and certain technicolor models. The observation of longitudinal polarization is a great help in seeing these effects in asymmetries in $e^+e^- \rightarrow \mu^+\mu^-, \tau^+\tau^-$ on Z^0 resonance.

52042 Nuclear structure in delta and S11 resonance regions. Doyle, B.C. (Rensselaer Polytechnic Institute, Troy, NY (US)). pp. 373-382 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

Recent pion photoproduction calculations in the 1p-shell use nuclear transition density matrix elements (TDRMEs) extracted from low energy electromagnetic and weak observables. The authors critique use of harmonic oscillator radial wavefunctions in these calculations for momentum transfers exceeding a cutoff obtained from fits to electron scattering form factors. Cutoffs are signaled by a rapid rise in χ^2 and are below the momentum transfer to the nucleus in the delta and S11 resonance regions for pion and eta photoproduction, respectively, for most of the differential cross-section's angular range. Due to the large eta mass (549 MeV), momentum transfer at threshold ($2.7fm^{-1}$) exceeds the cutoffs.

52043 Order α^2 δ corrections to W and Z transverse momentum distributions at the SPS and Tevatron colliders. Arnold, P.B. (Fermilab, Batavia, IL (US)); Reno, M.H. pp. 336-344 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The authors present numerical results from the full $\alpha_s{}^2$ computation of $d\sigma/dq^2{}_T$ for W's and Z's at square root s = 630 and 1800 GeV.

52044 Searching for fourth-generation fermions at high-energy e^+e^- machines. Dorfan, J. (Stanford Linear Accelerator Center, Stanford Univ., Stanford CA (US)); Van Kooten, R.J. pp. 319-331 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The N.Y. Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper summarizes studies on the feasibility of searching for fourth-family fermions at high-energy e^+e^- machines. The authors describe their studies and include consideration of a canonical fourth family in the Standard Model. They suggest the possibility that the fourth-generation neutral lepton is massive.

52045 Radiative kaon capture in hydrogen. McIntyre, E.K. (Boston Univ., Boston, MA (US)); Booth, E.C.; Gall, K.P.; Miller, J.P.; Roberts, B.L.; Whitehouse, D.A.; Fickinger, W.J.; Robinson, D.K.; Hasinoff, M.D.; Measday, D.F.; Noble, A.J.; Hessey, N.P.; Lowe, J.; Horvath, D.; Sakitt, M.; Skelly, J. pp. 434-438 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

Negative kaons were stopped in liquid hydrogen to measure the radiative capture rates to $Y\gamma$ final states. Branching ratios for the reactions $K^-p \rightarrow \Lambda\gamma$ and $K^-p \rightarrow \Sigma^0\gamma$ provide information about the quark structure of the $\Lambda(1404)$. Superior photon resolution is needed to distinguish the signal photons from the background of π^0 decay photons. Such resolution was provided by a NaI detector, which has a resolution of 1.3% (FWHM) near 300 MeV. A description of the experimental technique and data reduction is presented, along with preliminary branching ratio results.

52046 Photon-photon physics with the Mark II at PEP. Gidal, G. (Lawrence Berkeley Lab. and Dept. of Physics, Univ. of California, Berkeley, CA (US)). pp. 418-434 of Proceedings of the VIIth international workshop on photon-photon. Courau, A.; Kessler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 485 DOE Contract AC03-76SF00098 ;AC03-76SF00515. (CONF-8604238–: 7. international workshop on photon-photon collisions, Paris (France), 1-5 Apr 1986).

This paper reports on photon-photon interactions studied with Mark II detector at PEP. The inclusive production of charged hadrons at large transverse momenta and the exclusive production of meson pairs at large invariant mass are compared with recent hard scattering calculations. Copious inclusive production of K^0's at large transverse momenta provides evidence for charm production. The radiative width of the f'(1520) is measured via its $K_s{}^0\bar{K}_s{}^0$ decay mode.

52047 Prospects of Tevatron upgrade. Syphers, M.J. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 581-598 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Following a brief review of the 1987 Fermilab collider run and the present status of the 1988 run, upgrade plans for the near-term are described. For further luminosity upgrades beyond 1992, several scenarios are currently being discussed, one of which includes the construction of two new 20 GeV rings which could raise the proton-antiproton collider luminosity by a factor of 50 over the original Tevatron I design. Another possible project, the construction of a high luminosity proton-proton collider, has also been investigated in detail. A third scenario, involving a new main injector to replace the main ring and a new higher energy superconducting synchrotron, is examined. It is hoped that this will result in a proposal. The major issues concerning these options are presented.

52048 CDF's prospect for top search and other heavy flavor physics. Yoh, J. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 685-698 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The ability of CDF to search for the top quark is discussed. For the 1988-9 run, we expect to collect data corresponding to 5 inverse picobarns for integrated luminosity, making the discovery of

a top quark with masses of up to 90 - 110 GeV likely. Future runs, with possible integrated luminosities of 15, 50 and 500 inverse picobarns, should achieve mass limits of respectively 125, 150, and 220 GeV. The most likely mode for discovery is discussed, along with some discussion of probable backgrounds. A preliminary analysis of data from the CDF run of 1987 is used to set limits on possible backgrounds to a top signal. Prospects for other heavy flavor physics are also briefly discussed.

52049 **Observation of narrow structures in the *p-p* elastic analyzing power.** Shimizu, H. (Department of Physics, Tokyo Institute of Technology, Tokyo 152 (Japan)); Yoshida, H.Y.; Ohnuma, H.; Kobayashi, Y.; Kobayashi, K.; Nakagawa, T.; Holt, J.A.; Glass, G.; Hiebert, J.C.; Kenefick, R.A.; Nath, S.; Northcliffe, L.C.; Simon, A.; Hira *Physical Review, C (Nuclear Physics) (USA)*, 42(2): R483-R486 (Aug 1990). DOE Contract FG05-88ER40399.

The momentum dependence of the analyzing power A_y in proton-proton elastic scattering has been measured in small steps using an internal target during polarized beam acceleration from 1 to 3 GeV/*c*. The momentum bin size ranges from 5 to 18 MeV/*c*. The relative uncertainty of A_y is typically less than 0.01 for each momentum bin. Narrow structures have been found in the two-proton invariant mass distribution of A_y.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 52028, 52091, 52096, 52099, 52100, 52126, 52127, 52128, 52130, 52131, 52132, 52133, 52134, 52135, 52138, 52139, 52143, 52145, 52146, 52147, 52148, 52149, 52151, 52153, 52154, 52224, 52347, 52349

52050 (BONN-ME-90-04) **Vector meson dominance and pointlike coupling of the photon in soft and hard processes.** Paul, E. Bonn Univ. (Germany, F.R.). Physikalisches Inst. May 1990. 23p. (CONF-9002151--: Workshop on vector dominance phenomena in the interaction of photons with hadrons and nuclei, Goettingen (Germany, F.R.), 20 Feb 1990). Order Number DE91706311. Source: NTIS (US Sales Only), PC A03/MF A01.

Recent experimental results on photoproduction of hadrons probe the nature of the interacting photon over a wide kinematical range from soft to hard processes. Single inclusive spectra and energy flows of the final state charged particles are well described by assuming that photon production data are built up by an incoherent superposition of a soft Vector-Meson-Dominance component and a hard pointlike photon component. (orig.).

52051 (DOE/ER/40150-130) **Peturbative gluon exchange in a covariant quark model of the pion.** Ito, Hiroshi (Hampton Inst., VA (USA). Dept. of Physics); Buck, W.W.; Gross, F. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. [1990]. 16p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration; National Science Foundation. DOE Contract AC05-84ER40150 ;FG05-88ER40435. Grant RII-8704038;Grant NAG-1-447. (CEBAF-PR-90-006). Order Number DE91000626. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A covariant pion wave function, which reproduces the low energy data, is used to calculate the perturbative gluon exchange contributions to the pion charge form factor. It is found that the perturbative process dominates at $q > 3.5$ GeV/c. The dependence on the quark mass and the asymptotic behavior of the form factor are explicitly displayed.

52052 (DOE/ER/40150-136) **Standard model bosons as composite particles.** Kahana, D.E. (Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility); Kahana, S.H. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150 ;AC02-76CH00016. (CEBAF-PR-90-001). Order Number DE91000430. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Standard model of electro-weak interactions is derived from a Nambu, Jona-Lasinio type four-fermion interaction, which is assumed to result from a more basic theory valid above a very high scale Λ. The masses of the gauge bosons and the Higgs are then produced by dynamical symmetry breaking of the Nambu model at an intermediate scale μ, and are evolved back to experimental energies via the renormalisation group equations of the Standard model. The weak angle $\sin^2(\theta_W)$ is predicted to be 3/8 at the scale μ, as in grand unified theories, and is evolved back to the experimental value at scale M_W, thus determining $\mu \sim 10^{13}$GeV. Predictions for the ratios of the masses of the gauge and the Higgs bosons to the top quark mass, at experimental energies, are also obtained.

52053 (DOE/ER/40213-7) **Theory and phenomenology of strong and weak interaction high energy physics: Progress report.** Carruthers, P.; Thews, R.L. Arizona Univ., Tucson, AZ (USA). Dept. of Physics. 29 Aug 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER40213. Order Number DE91000977. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper deals with research being conducted at the University of Arizona in the theory of strong and weak interactions. Topics in Quantum chromodynamics, quantum electrodynamics, symmetry principle, hadronic structure of the photon and other are discussed. (LSP)

52054 (GSI-90-34(prepr.)) **Localized Higgs-Fermion states.** Harley, D. (Arizona Univ., Tucson (USA). Dept. of Physics); Soff, G.; Rafelski, J. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 10p. Order Number DE91706320. Source: NTIS (US Sales Only), PC A02/MF A01.

We obtain spherically symmetric classical solutions to the strongly coupled Higgs-Fermion fields in the electroweak $SU(2)_L xU(1)_y$ standard model. We find that there exists an upper limit on the physical mass of Fermions due to the non-perturbative distortion of the Higgs vacuum in the vicinity of localized Fermion solutions. For a reasonable range of Higgs masses, the upper limit on the Fermion mass is of the order of 2 TeV. (orig.).

52055 (GSI-90-37(prepr.)) **Strangeness and quark gluon plasma: Aspects of theory and experiment.** Eggers, H.C. (Arizona Univ., Tucson (USA). Dept. of Physics); Rafelski, J. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 42p. Order Number DE91706312. Source: NTIS (US Sales Only), PC A03/MF A01.

A survey of our current understanding of the strange particle signature of quark gluon plasma is presented. Emphasis is placed on the theory of strangeness production in the plasma and recent pertinent experimental results. Useful results on spectra of thermal particles are given. (orig.).

52056 (INS-832) **Comment on confining theory of quarks, leptons and sarks.** Yasue, Masaki. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1990. 14p. Order Number DE91713079. Source: NTIS (US Sales Only), PC A03/MF A01.

The confining $SU(2)_L^{loc}$ theory for composite quarks, leptons and extra weak-triplet and-singlet fermions (called sarks), which fixes the generation number ≤ 3 as suggested by Frampton and Ng (FN) in their sark model, is shown to incorporate extra composite W and Z bosons, W' and Z', as the remnant of confined hypercolors carried by sark constituents. The model deals with $SU(2)_L^{loc}$- and hypercolor-singlet composites that exhibit the duality of compositeness and 'elementariness', in which it differs from the original FN's sark model. W' and Z' primarily couple to sarks but not to quarks and leptons while the indirect coupling of Z' to quarks and leptons is induced as a result of vector meson dominance of the photon. (author).

52057 (INS-833) **Atmospheric neutrino fluxes.** Honda, M. (Tokyo Univ., Tanashi (Japan). Inst. for Cosmic Ray Research); Kasahara, K.; Hidaka, K.; Midorikawa, S. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1990. 17p. Order Number DE91713078. Source: NTIS (US Sales Only), PC A03/MF A01.

A detailed Monte Carlo simulation of neutrino fluxes of atmospheric origin is made taking into account the muon polarization effect on neutrinos from muon decay. There still remains a significant discrepancy between the calculated $(\nu_e + \text{anti}\nu_e)/(\nu_\mu + \text{anti}\nu_\mu)$ ratio and that observed by the Kamiokande group, which can be explained by three neutrino oscillations. However, the ratio

evaluated at the Frejus site and the total event number calculated for IMB-1 show good agreement with the data. Comparing out result with the previous Monte Carlo calculation by Barr et al., we find that the two calculations agree within 20 % for the magnitude of neutrino fluxes and 5 % for the $(\nu_e + \text{anti}\nu_e)/(\nu_\mu + \text{anti}\nu_\mu)$ ratio. This paper is the revised version for correcting computational errors in the previous preprint, INS-Rep.-807. (J.P.N.).

52058 (IS-M–651) **Radiative corrections and Z′ searches at ep colliders.** Rizzo, T.G. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics). Ames Lab., IA (USA). [1990]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. (CONF-9006267–5: 1990 DPF summer study on high energy physics, Snowmass, CO (USA), 25 Jun - 13 jul 1990). Order Number DE91000084. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

We examined the sensitivity of the Z′ searches at ep colliders to the unknown values of the top quark and Higgs boson masses (m_t and m_H) in a number of extended electroweak models through the use of polarization asymmetries including the effects of weak radiative corrections.

52059 (IS-M–652) **New gauge boson mass bounds from radiative corrections.** Rizzo, T.G. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics). Ames Lab., IA (USA). [1990]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. (CONF-9006267–6: 1990 DPF summer study on high energy physics, Snowmass, CO (USA), 25 Jun - 13 jul 1990). Order Number DE91000085. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

Recent data from LEP, the Tevatron, and the CERN Collider on the properties of the W and Z are used together with our knowledge of the radiative corrections in the Standard Model (SM) to place 95% CL lower bounds on the masses of new neutral gauge bosons in a number of extended electroweak models.

52060 (IS-T–1446) **Neutral technicolor pseudo Goldstone bosons production and QCD [quantum chromodynamics] background at the SSC [Superconducting Super Collider].** Kuo, Wang-Chuang. Ames Lab., IA (USA). 21 Sep 1990. 128p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000195. Source: NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

The production of the neutral technicolor pseudo Goldstone bosons, $P^{0\prime}$ and $P_8^{0\prime}$, at large transverse momentum in pp collisions, $pp \to g(q)P^{0\prime}$ ($P_8^{0\prime}$)X has been investigated in reactions at a high energy collider such as the SSC. The major two-body and three-body decay modes in tree diagrams are investigated in detail. The $t\bar{t}$ decay channel would dominate both the decays of $P^{0\prime}$ and $P_8^{0\prime}$ if it is allowed. Otherwise, gg and 3g will be the dominant decay modes unless the mass of the $P^{0\prime}$ and $P_8^{0\prime}$ are below 40 GeV, where $b\bar{b}$ becomes dominant. According to the QCD backgrounds, which we have also investigated in detail in this work, the signal for $t\bar{t}$ is much larger than the background and will be the ideal signal for detecting these bosons. However, in the absence of the $t\bar{t}$ channel, the $\tau\bar{\tau}$ mode can be used to identify $P^{0\prime}$ up to m_P = 300 GeV in the transverse momentum range $P_\perp \lesssim 100$ GeV. Similarly, the $b\bar{b}$ decay mode can serve us a signal to identify $P_8^{0\prime}$ up to m_P = 300 GeV for $P_\perp$ between 500 and 700 GeV. Our results show that these high transverse momentum production processes are useful for the searching for the $P_8^{0\prime}$ at the SSC. 63 refs.

52061 (KFTI–88-29) **On the supersymmetric generalizations of the action of relativistic massless particles.** Volkov, D.V.; Zheltukhin, A.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 15p. (In Russian). Order Number DE91603070. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A supersymmetrical extension of the Penrose twistor representation is suggested and classical equivalence between the theories of spinning and supersymmetrical particles is established. It is shown that the extended Penrose representation is a consequence of the inverse Higgs effect for locally and globally invariant spinor superform. This condisions is generalized to strings and leads to a connection of the grassmanian variables of fermionic strings and superstrings. The method of constructing superfield lagrangians or particles and strings invariant ubder local and global supersymmetries is formulated. 21 refs.

52062 (KFTI–88-31) **On the twistor representation of Siegel transformation for superparticles.** Volkov, D.V.; Sorokin, D.P.; Tkach, V.I. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 12p. (In Russian). Order Number DE91603071. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that an explicit incorporation of twistor variables into the Lagrangian of a massless relativistic particle together with the local supersymmetrization of its proper time leads to a Lagrangian which is invariant under the space-time global supersymmetry. The equivalence of the Siegel symmetry and the local proper-time supersymmetry with a complexified grassmanian parameter is established. The Siegel algebra is formed by an irreducible set of covariant constraints and is closed off shell. 20 refs.

52063 (LBL–29466) **Heavy quark production at SLC and LEP.** Hearty, C. Lawrence Berkeley Lab., CA (USA). Jun 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9006268–2: 10. international conference on physics in collision, Durham, NC (USA), 21-23 Jun 1990). Order Number DE91000225. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Experiments at SLC and LEP have made preliminary measurements of the relative partial widths of the c and b quarks. Using D^* tagging, DELPHI has found $R_c\bar{c} \equiv \Gamma_{c\bar{c}}/\Gamma_{hadr.} = 0.162 \pm 0.032 \pm 0.031$, in good agreement with the Standard Model value of 0.171. ALEPH has used semileptonic decays of charm to obtain $0.148 \pm 0.044\ ^{+0.045}_{-0.038}$. Three experiments have used semileptonic B decays to measurement $R_b\bar{b}$: $R_b\bar{b} = 0.23 \pm 0.10$ (Mark II), $0.218 \pm 0.010 \pm 0.021$ (L3), and $0.220 \pm 0.016 \pm 0.024$ (ALEPH). All agree well with the expected value of 0.217. The uncertainty in branching ratios of c and b hadrons is the largest systematic error in all of the results. Future LEP measurements of the branching ratios may reduce the errors. $R_b\bar{b}$ will also be measured with different, and possibly lower, systematic errors by Mark II using impact parameter tagging.

52064 (LU-TP–90-1) **New results in quantum chromodynamics.** Gustafson, Goesta. Lund Univ. (Sweden). Dept. of Theoretical Physics. Jan 1990. 28p. (CONF-8912118–: 1. international workshop on selected topics in theoretical physics, Hanoi (Viet Nam), Dec 1989). Order Number DE91603048. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Recent developments in QCD are discussed in particular how the dipole formalism and a recently proposed multiplicity measure can be used as efficient tools to study the properties of the QCD shower evolution. The focus is on applications to e^+e^--annihilation into hadrons.

52065 (LU-TP–90-5) **Fractal structures and intermittency in QCD.** Gustafson, Goesta. Lund Univ. (Sweden). Dept. of Theoretical Physics. Apr 1990. 21p. (CONF-9003215–: Santa Fe workshop on intermittency in high energy collisions, Santa Fe, U (USA), 13 Mar 1990). Order Number DE91603049. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

New results are presented for fractal structures and intermittency in QCD parton showers. A geometrical interpretation of the anomalous dimension in QCD is given. It is shown that model predications for factorial moments in the PEP-PETRA energy range are increased. if the properties of directly produced pions are more carefully taken into account.

52066 (MPI-PAE/Exp.El.–230) **Reinvestigation of compositeness limits from e^+e^- annihilation.** Kroha, H. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Aug 1990. 18p. (CONF-900822–: 25. IUPAP international conference on high energy physics, Singapore (Singapore), 2-8 Aug 1990). Source: Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.

Data of the PEP and PETRA experiments on lepton pair production have been investigated in terms of compositeness. Different

methods are compared for treating the common normalization errors of the data points when fitting the predicted cross sections. We discuss difficulties in the interpretation of experimental limits on the compositeness scale Λ not mentioned in previous measurements. Λ turns out not to be the appropriate parameter to estimate effects of a possible substructure of quarks and leptons. Limits on Λ from different experiments can neither be compared nor combined. A combined analysis of the cross section measurements at PEP and PETRA has therefore been performed in order to determine to which extent new contact interactions can be excluded from present e^+e^- annihilation data. (orig.).

52067 (PHE–86-13, pp. 184-200) **Naturally light higgs doublets in grand unified models.** Krasnikov, N.V. (AN SSSR, Moscow (USSR). Inst. Yadernykh Issledovanij). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The fine tuning problem in grand unified theories is reviewed. It is shown that the nonlocal gauge models with the nonlocal scale $\Lambda \leq 0(1)$ Tev solve the gauge hierarchy problem at least in a technical way. A new mechanism for the explanation of the doublet-trilet problem (problem of the naturally light higgs doublets) is proposed. It is shown that it is possible to break the supersymmetry in the $\alpha = 4$ $E_8 \times E_8$ gauge supersymmetric theory obtained as a low energy limit of superstring theory by nonzero gluino condensates if the E_8 gauge group is broken to $G_1 \times G_2$. (author).

52068 (PHE–86-13, pp. 201-203) **Structure of fermion mass matrices in high dimensional theories.** Wetterich, C. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The structure of fermion mass matrices in higher dimensional theories is investigated considering Yukawa couplings. It is argued that generically no small Yukawa couplings appear in high dimensional theories unless they are protected by symmetries or topological reasons. It is concluded that the structure of fermion mass matrices becomes related to a fine structure of scales at the unification scale.

52069 (PHE–86-13, pp. 215-225) **On dimensional reduction of Einstein-Cartan theory.** Rudolph, G. (Leipzig Univ. (German Democratic Republic). Sektion Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Dimensional reduction of pure gauge theories and gravity is studied. In this framework first the generalized Kaluza-Klein idea based on spontaneous compactification and harmonic expansion as well as the possible role of torsion are investigated. Then a full classification of G-invariant configurations of Einstein-Cartan theory is given. Propositions and theorems are derived and the results are discussed.

52070 (PHE–86-13, pp. 320-333) **Quark-antiquark pair creation in radiative Ψ and Υ transitions.** Lewin, K. (Humboldt-Universitaet, Berlin (German Democratic Republic). Sektion Physik); Motz, G.B. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The contributions of internal charm- and bottom-quark pair creation to some radiation transition rates in the Ψ and Υ family of narrow resonances, respectively, are studied using time-dependent perturbation theory. The lowest order pair creation correction to these radiative transition rates obtained in a quasilocal approximation is applied to electromagnetic charmonium and bottomonium transitions. The used quasilocal approximation shows results with a good accuracy for the bottomonium case.

52071 (SLAC-PUB–5323) **CP asymmetries in B^0 decays beyond the Standard Model.** Dib, C.O. (California Univ., Los Angeles, CA (USA). Dept. of Physics); London, D.; Nir, Y. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Aug 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9006275–1: Workshop on physics and detector issues for a high-luminosity asymmetric B factory, Stanford, CA (USA), 4-8 Jun 1990). Order Number DE91000055. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Of the many ingredients of the Standard Model that are relevant for the analysis of CP asymmetries in B^0 decays, some are likely to hold even beyond the Standard Model while other are sensitive to new physics. Consequently, certain predictions are maintained while other may shoe dramatic deviations from the Standard Model. Many classes of models may show clear signatures when the asymmetries are measured: four quark generations, Z-mediated flavor changing neutral currents, supersymmetry and "real superweak" models. On the other hand, models of left-right symmetry and multi-Higgs sectors with natural flavor conservation are unlikely to modify the Standard Model predictions.

52072 **Theoretical expectations for mass scales of the fourth generation and Higgs bosons.** Hill, C.T. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 168-179 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses two classes of theories that have something to say about fourth-generation quark and lepton masses. One is based upon universality of low-energy parameters as determined by the renormalization group: infrared fixed points. The other is a toy model of geometric hierarchy that may arise in a novel scheme of dimensional reduction without compactification.

52073 **Photon scattering from the nucleon at LEGS.** Sandorfi, A.M. (Physics Dept., Brookhaven National Lab., Upton, NY (US)); Kistner, O.C.; Matone, G.; Thorn, C.E.; Whisnant, C.S.; Giordano, G.; Schaerf, C.; Blanpied, G.; Preedom, B.M.; Sealock, R.M.; Thornton, S.T. pp. 256-277 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 DOE Contract AC02-76CH00016. (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

The elastic scattering of linearly polarized photons is discussed as a means of measuring the E2/M1 mixing ratio in the excitation of the delta (1232) resonance. The crucial problem in extracting this quantity is the presence of interfering backgrounds. The difference of two scattering cross sections with different incident polarizations can be used to eliminate almost all of the background contributions. As a measure of the sensitivity of this method, such a cross section difference can exhibit a change of 2.4% for an E2/M1 ratio of one percent. The single correction of importance comes from the imaginary part of the fmm(1-) amplitude for magnetic dipole scattering through a spin 1/2 state.

52074 **A dynamical model of pion photoproduction on nucleon in Δ-region.** Blankleider, B. (Paul Scherrer Institute, CH-5234, Villigen (CH)); Lee, T.S.H.; Nozawa, S. pp. 288-292 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565

(CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

Theoretical study has been done on pion photoproduction on the nucleon. Pion production by photons and/or electrons on a nucleon is attractive, because it is the simplest reaction to explore the $\Delta \rightarrow N\gamma$ transition amplitudes. A simple quark model gives pure M1 (or M_{1+}) transition, however, there exists a non-zero E2(or E_{1+}) transition amplitude experimentally. In quark models the non-vanishing E2 amplitude is realized, for example, by an admixture of D-state baryon wave function due to one gluon exchange between quarks. The authors present a model of pion photoproduction which includes FSI in a dynamical way. The model is unitary as well as gauge invariant.

52075 **Approximate four jet cross sections.** Mangano, M. (Fermi National Accelerator Lab., Batavia, IL (US)); Parke, S. pp. 288-298 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Approximate matrix elements squared are given for all parton processes involving a quark-antiquark pair plus four gluons. Detailed comparisons are made between these results and the exact matrix elements for the subprocesses involving a quark-antiquark pair and four gluons in four jet production at hadron colliders. Together with Maxwell's approximate result for six gluon processes an excellent agreement is found for the shape and total cross section of four jet production.

52076 **Loop-induced rare B decays and the fourth generation.** Soni, A. (Dept. of Physics and Astronomy, Univ. of Pittsburg, Pittsburg, PA (US)); Hou, G.W.S. pp. 255-267 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses loop-induced rare B decays, $b \rightarrow s l^+ l^-$, $s\nu\bar{\nu}$, $s\gamma$, and QCD-induced $b \rightarrow s$ transitions (penguins). Decay rate growth is addressed. The authors point out a pragmatic parameterization of the 4 x 4 mixing matrix suitable for B physics.

52077 **Index theory analysis of Fermion number fractionization.** Niemi, A.J. (Institute for Advanced Study, Princeton, NJ (US)); Semenoff, G.W. pp. 449-462 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper discusses how topologically nontrivial background fields induce zero modes for certain conjugation symmetric Dirac Hamiltonians and that the ensuing ground state degeneracy leads to quantum states with fractional fermion number. An open infinite space index theorem for a special class of Dirac operators is described.

52078 **Chiral weak dynamics.** Morozumi, T. (Rockefeller University, 1230 York Avenue, New York, New York 10021 (USA)); Lim, C.S.; Sanda, A.I. *Physical Review Letters (USA),* 65(4): 404-407 (23 Jul 1990). DOE Contract AC02-87.

We derive a chiral weak Lagrangian which interpolates the QCD-corrected-four-fermion weak-interaction Lagrangian to low energies. This is done using the Nambu–Jona-Lasinio model as a guide. The derivation treats SU(3) breaking from the current-quark mass on an equal footing with the spontaneous chiral-symmetry breaking. It leads naturally to an additional factor of 2–4 enhancement of ΔI=1/2 $K \rightarrow \pi\pi$ decay amplitudes.

52079 **Backgrounds to hadronic Higgs-boson detection in a 1-TeV e^+e^- collider.** Yehudai, E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (USA)). *Physical Review, D (Particles Fields) (USA),* 42(3): 771-776 (1 Aug 1990). DOE Contract AC03-76SF00515.

We calculate the cross section of all standard-model processes which constitute a potential background to the hadronic decays of an intermediate-mass neutral Higgs boson in a 1-TeV e^+e^- collider. These calculations are performed taking into account a realistic photon distribution which is due to beamstrahlung. Imposing appropriate kinematic cuts, and for $m_H > 125$ GeV, the Higgs-boson signal is visible above this background. Distinguishing bottom jets from light-quark jets can greatly enhance the signal-to-noise ratio.

52080 **Higgs-boson production in higher-order electroweak processes at e^+e^- supercolliders.** Barger, V. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Han, T.; Stange, A. *Physical Review, D (Particles Fields) (USA),* 42(3): 777-788 (1 Aug 1990). DOE Contract AC02-76ER00881.

We evaluate the production cross sections and some dynamical distributions for the processes $e^+e^- \rightarrow WWH$, $\gamma ZH, ZZH$, and $e^+e^- \rightarrow \nu eWH$, $\nu\bar{\nu}ZH$, $\nu\bar{\nu}\gamma H$. For m_H=25 GeV the cross sections at $\sqrt{s}$ =0.3 TeV are $\sigma(WWH)$=57 fb and $\sigma(\gamma ZH)$=13 fb; for m_H=50 GeV and $\sqrt{s}$ =2 TeV, $\sigma(e\nu WH)$=20 fb and $\sigma(\nu\bar{\nu}\gamma H)$=11 fb. If $m_H < M_Z$, these processes should be measurable at an e^+e^- supercollider with 10 fb^{-1} annual luminosity.

52081 **Towards a systematic jet classification.** Jones, L. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, IL (USA)). *Physical Review, D (Particles Fields) (USA),* 42(3): 811-814 (1 Aug 1990). DOE Contract AC02-76ER01195.

A method of classifying hadron jets is presented which uses the z correlations of all hard particles in the jet. We show that this leads to cuts which will allow preparation of "quark-enhanced" samples of jets. Such samples should be useful for computing the W mass in jet-jet invariant-mass distributions, and in searches for new particles which decay predominantly into jets. We urge experiments with e^+e^- data to test these theoretical predictions by comparisons of their "quark-enhanced" and "gluon-enhanced" jet samples.

52082 **Excited-quark and -lepton production at hadron colliders.** Baur, U. (Physics Department, University of Wisconsin, Madison, WI (USA)); Spira, M.; Zerwas, P.M. *Physical Review, D (Particles Fields) (USA),* 42(3): 815-824 (1 Aug 1990). DOE Contract AC02-76ER00881.

The existence of excited states is a natural consequence of composite models for quarks and leptons. Production rates and signatures are discussed for hadron colliders presently operating (CERN Super $p\bar{p}$ Synchrotron and Fermilab Tevatron) or under study (CERN Large Hadron Collider and Superconducting Super Collider). Contact interactions may be an important source for excited fermions and could influence the signatures of such particles significantly. Excited quarks could be discovered with masses up to about 1/3–1/2 of the total collider energy while excited leptons could be accessible up to 1/5–1/3 of the available energy. Large lepton yields are expected if quarks and leptons share common subconstituents.

52083 **Goldstone-boson equivalence theorem and the Higgs resonance.** Valencia, G. (Department of Physics, Brookhaven National Laboratory, Upton, NY (USA)); Willenbrock, S. *Physical Review, D (Particles Fields) (USA),* 42(3): 853-859 (1 Aug 1990). DOE Contract AC02-76CH00016.

The Goldstone-boson equivalence theorem equates the amplitude for longitudinal-vector-boson scattering to the corresponding amplitude for the scattering of the Goldstone bosons of the R_ξ gauge. When the Higgs-boson width is included in the Higgs-boson propagator, this equality is apparently lost. We show that this apparent violation of the theorem is a result of making an inconsistent perturbative expansion of the amplitude. We demonstrate this for the process $W_L^+W_L^- \rightarrow W_L^+W_L^-$ both on resonance ($s=m_H^2$) and far below ($s \ll m_H^2$). We also reformulate the scalar sector of the standard model in such a way that the equivalence theorem is manifestly upheld in the presence of a Higgs-boson width.

52084 **Top-quark backgrounds to Higgs-boson decay to W^+W^-.** Kauffman, R.P. (High Energy Physics Division, Argonne National Laboratory, Argonne, IL (USA)); Yuan, C. *Physical Review, D (Particles Fields) (USA),* 42(3): 956-959 (1 Aug 1990). DOE Contract W-31109-ENG-38.

At the Superconducting Supercollider W-boson pairs coming from $t\bar{t} \rightarrow b\bar{b}W^+W^-$ provide a serious background to the detection

of the Higgs boson through the decay $H \rightarrow W^{+}W^{-} \rightarrow l\nu+2$ jets, a mode crucial to the study of longitudinal Ws in the TeV region. Considering a Higgs-boson mass of 1 TeV and a top-quark mass of 175 GeV we develop a set of cuts which yield a final signal-to-background ratio of approximately 3:1 and about 300 signal events. Most effective are the requirements of lepton isolation and high transverse momentum for the lepton and jets.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 52041, 52053, 52071, 52074, 52078, 52083, 52121, 52123, 52125, 52126, 52128, 52132, 52133, 52137, 52139, 52141, 52142, 52145, 52149, 52203

52085 (DOE/ER/40209–11) **On gauged Baryon and Lepton numbers.** Rajpoot, S. Wayne State Univ., Detroit, MI (USA). Dept. of Physics and Astronomy. [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER40209. (CONF-9002118–3: 1990 Lake Louise winter institute: the standards model and beyond, Lake Louise (Canada), 18-24 Feb 1990). Order Number DE91000008. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The observation that Baryon number and Lepton number are conserved in nature provides strong motivation for associating gauge symmetries to these conserved numbers. This endeavor requires that the gauge group of electroweak interactions be extended from $SU(2)_L \times U(1)_Y$ to $SU(2)_L \times U(1)_R \times U(1)_{Lepton}$ where $U(1)_R$ couples only to the right-handed quarks and leptons. If it furthur postulated that right-handed currents exist on par with the left-handed ones, then the full electroweak symmetry is $SU(2)_L \times SU(2)_R \times U(1)_{Baryon} \times U(1)_{Lepton}$. The $SU(2)_L \times SU(2)_R \times U(1)_{Baryon} \times U(1)_{Lepton}$ model is described in some detail. The triangle anomalies of the three families of quarks and leptons in the model are cancelled invoking leptoquark matter which is new fermionic matter that carries baryon as well as lepton numbers. In addition to the standard neutral boson (Z °), the theory predicts two neutral gauge bosons with mass lower bounds of 120 GeV and 210 GeV which makes these particles prospective candidates for production at LEP, the TEVATRON and the SSC.

52086 (PHE–86-13, pp. 1-30) **Supersymmetric gauge theories.** Kummer, W. (Technische Hochschule, Vienna (Austria). Inst. fuer Theoretische Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The powerful methods of superfields and superspace are extended to general linear gauges in which supersymmetry is not manifest. Such a program is motivated by the fact that (1) the renormalization program for nonabelian super-Yang-Mills fields is well-known to be ill-defined without breaking of supersymmetry in the gauge; (2) it is desireable also to implement 'physical' gauges like the Wess-Zumino gauge, into a superfield formalism. (author).

52087 (PHE–86-13, pp. 46-60) **Supersymmetric quantum mechanics in curved manifold.** Alfaro, V. de (Turin Univ. (Italy). Ist. di Fisica Teorica). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The quantum mechanical model of a supersymmetric particle in curved manifolds is analyzed. First the model is introduced by the superfield formalism. Then the canonical formalism as well as the quantum form for the Hamiltonian and for the quantum operators of supersymmetry are presented and discussed. Finally the implementation of General Coordinate Transformation (GCT) invariance and the connection with Weyl ordering are discussed.

52088 (PHE–86-13, pp. 61-73) **On supersymmetric anomalies.** Garreis, R. (Karlsruhe Univ. (T.H.) (Germany, F.R.)). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Chiral anomalies occur in supersymmetry which destroy gauge invariance are computed by perturbation field theoretical as well as algebraic methods. The results and the relations between both methods are discussed.

52089 (PHE–86-13, pp. 306-319) **Nonlinear Schroedinger model, Grassmann variable and solitons.** Hruby, J. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Bednar, M. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The Grassmann variable is used for the extension of the nonlinear Schroedinger model. The system of coupled non-linear equations is obtained and its one-soliton solution is found. The correspondence to the reflectionless potential in Schroedinger equation is discussed. Korteweg-de Vries equation, Miura transformation, reflectionless potential and supersymmetric quantum mechanics is discussed as well. (author).

52090 (PHE–86-13, pp. 341-345) **Supergeometric interpretation of classical fermion fields.** Schmitt, T. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Karl-Weierstrass-Inst. fuer Mathematik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

It is proved that approaches with Λ-valued configurations cannot be the proper answer to the question what a classical fermion field is. That's why a program based on supergeometry is presented in order to understand classical fermion fields.

52091 **Sizes of baryon confinement regions.** Brown, G.E. (Dept. of Physics, State Univ. of New York at Stony Brook, Stony Brook, NY (US)). pp. 17-31 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808196–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

Arguments are presented that R $\geq$ 0.5 fm; more specifically, $\theta(R) = \pi/2$, where $\theta(R)$ is the chiral angle at the bag radius R, is appropriate for quark substructure of the nucleon. This cuts off the boson exchange potential at momentum $\Lambda_{\chi SB} \geq 1$ GeV. For this division, half of the baryon number lies in the interior region and half in the exterior. For strange baryons with little pion cloud to compress the confinement region, R may be 1-1.1 fm as in the M.I.T. bag model. For this radius, a good phenomenology results for magnetic moments. On the other hand, the Callan-Klebanov model, which is also successful, corresponds, as the skyrmion, to R→O.

52092 **Superstrings.** Schwarz, H.H. (California Inst. of Tech., Pasadena, CA (USA)). pp. 50-60 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper surveys the present status of superstring theory. The derivation of the gauge groups SO(32) and $E_8 \times E_8$ is reviewed and the five known superstring theories are described.

52093 **Overview of the Standard Model.** Gilman, F.J. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). pp. 159-167 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 DOE Contract AC03-76SF00515. (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the accuracy of the predictions made by the standard Model. The author concentrates on several possible problem areas that are listed.

52094 **Status of CP violation experiments at Fermilab.** Bock, G.J. (Fermilab, Batavia, IL (US)). pp. 132-139 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper presents two preliminary results from *CP* violation experiments at Fermilab. The author concentrates on the ongoing experiment to search for direct CP violation in *K* decay. An experiment searching for *CP* violation in three-pion decay has preliminary limits that are also reported here.

52095 **Signatures of supersymmetry at the CERN collider.** Haber, H.E. (Santa Cruz Inst. for Particle Physics, Univ. of California, Santa Cruz, CA (US)). pp. 185-212 of Test of electroweak theories: Polarized processes and other phenomena. Lynn, B.W.; Verzegnassi, C. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 461 (CONF-8506204–: Workshop on tests of electroweak theories, polarized processes and other phenomena, Trieste (Italy), 10-12 Jun 1985).

This paper presents an analysis of missing energy events at the CERN Collider which would arise from a supersymmetric theory. The rates for gluino and scalar-quark production are computed. It is argued that the monojet events are highly unlikely to come from supersymmetric particle production. This implies very restrictive limits: M_g and M_q must be larger than 60-70 GeV. These conclusions have been obtained assuming that photinos are stable and are the lightest supersymmetric particle. The implications of a Higgsino which is lighter than the photino are also discussed.

52096 **Electroweak interactions at the SSC.** Cahn, R.N. (Lawrence Berkeley Lab., CA (USA)). pp. 173-184 of Test of electroweak theories: Polarized processes and other phenomena. Lynn, B.W.; Verzegnassi, C. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 461 DOE Contract AC03-76SF00098. (CONF-8506204–: Workshop on tests of electroweak theories, polarized processes and other phenomena, Trieste (Italy), 10-12 Jun 1985).

This paper discusses the standard SSC year which will provide roughly 10^9 single gauge boson events, 10^6 double gauge boson events and 104 triple gauge events. There is no known way to identify the hadronic decays of the W and Z so the number of identifiable gauge bosons will be much reduced. Within the simplest version of the orthodox electroweak model, the Higgs boson is an elusive target. If its mass is greater than twice the W mass, it decays into W^+W^- (or ZZ). A standard SSC year will produce about 100,00 Higgs bosons if $M_H = 300$ GeV. The author reports that the only sure signature is from $H \rightarrow ZZ$ with both Z's decaying leptonically. This leaves 120 events before kinematical cuts. This is a pessimistic scenario but a feasible one. The greatest improvement would come from an effective means of identifying gauge by their hadronic decays.

52097 **Anomalies, cocycles and Schwinger terms.** Zumino, B. (Lawrence Berkeley Lab., CA (USA)). pp. 111-128 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 DOE Contract AC03-76SF00098. Grant PHY-81-18547. (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper reviews the properties of cocycles on a gauge group and its Lie algebra and their relationship to gauge anomalies. The case of supersymmetric gauge theories is discussed.

52098 **Future prospects for CP violation.** Morrison, R.J. (Univ. of California, Dept. of Physics, Santa Barbara, CA (US)). pp. 719-738 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Prospects for observing CP violation in B decays in different experimental environments are discussed. Different energy ranges for e^+e^- colliders, just above the 4s, $\sqrt{s} \approx 25$GeV, and at the Z are compared. Virtual photoproduction at HERA, fixed target hadronic production at the Fermilab, and hadron-hadron colliders at RHIC, the Tevatron, and the SSC are discussed.

52099 **Limits on the masses of supersymmetric particles from 1.8 TeV $\bar{p}$ – p collisions.** Freeman, J. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 762-773 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Preliminary analysis of $\bar{p}$ - p collision events at a c.m. energy of 1.8 TeV with large missing transverse energy yields limits on the production cross-section for one-jet events with observed jet transverse energy $E_T > 40$ GeV. For jets in the pseudo-rapidity range $|\eta| < 1.0$, the production cross- section is <0.14 nb. In a minimal supersymmetry model, the mass of the squark must be larger than 84 ± 10 GeV, independent of the mass of the gluino, at the 90% confidence level. The mass of the gluino must be larger than 82 ± 10 GeV, independent of the mass of the squark. The uncertainties are the combined effects of several sources of systematic error in this preliminary result.

52100 **Restrictions on gravitino mass from chiral scalar and pseudoscalar production.** Dicus, D.A. (Center for Particle Theory, University of Texas at Austin, Austin, TX (USA)); Roy, P. *Physical Review, D (Particles Fields) (USA)*, 42(3): 938-940 (1 Aug 1990). DOE Contract FG05-85ER40200.

A lower bound of 5.4×10^{-16} is shown to follow on the gravitino-photino mass ratio from the observed lack of occurrence of the processes $e^+e^- \rightarrow \gamma S, \gamma P$, where *S* and *P* are the nearly massless chiral scalar and pseudoscalar, respectively. For a large class of theories with unified gaugino masses, this is convertible into a lower limit of 6.5×10^{-15} GeV on the gravitino mass.

6454 Field Theory

Refer also to citation(s) 51596, 52028, 52031, 52038, 52048, 52076, 52077, 52091, 52097, 52099, 52330, 52337, 52346

52101 (BONN-HE-90-07) **Deformations along critical lines of field theories in two dimensions.** Chaselon, P. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.); Flume, R.; Constantinescu, F. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Aug 1990. 9p. Source: Available from Bonn Univ. (Germany, F.R.). Physikalisches Inst.

We investigate deformations of two dimensional quasirational conformal field theories through marginal deformations. A recursive representation of the perturbation expansion is found which allows to keep track of the variation of the data of the conformal field theory to arbitrary order. The emerging generalized Kadanoff-Brown criterion for true marginality is discussed. (orig.).

52102 (IC–90/96) **Reduction of 4-dim self dual super Yang-Mills onto super Riemann surfaces.** Mendoza, A. (Universidad Simon Bolivar, Caracas (Venezuela). Dept. de Fisica); Restuccia, A.; Martin, I. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 8p. Order Number DE91602737. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Recently self dual super Yang-Mills over a super Riemann surface was obtained as the zero set of a moment map on the space of superconnections to the dual of the super Lie algebra of gauge transformations. We present a new formulation of 4-dim Euclidean self dual super Yang-Mills in terms of constraints on the supercurvature. By dimensional reduction we obtain the same set of superconformal field equations which define self dual connections on a super Riemann surface. (author). 10 refs.

52103 (IC–90/109) **Partition function for N=2 superstring on the torus.** Aldazabal, G. (Comision Nacional de Energia Atomica, San Carlos de Bariloche (Argentina). Centro Atomico Bariloche); Allekotte, I.; Bonini, M.; Nunez, C. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 14p. Order Number DE91602735. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A general 1-loop partition function for the 4 dimensional superstring is explicitly constructed as a tensor product of N=2 superconformal theories. Its vanishing is shown by using a generalized Riemann identity. (author). 11 refs.

52104 (IC–90/142) **Gauge-field topology in two dimensions: θ-vacuum, topological phases and composite fields.** Ilieva, N. (International Centre for Theoretical Physics, Trieste (Italy)); Pervushin, V.N. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 16p. Order Number DE91602736. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the framework of the minimal quantization method, the residual 'longitudinal' vacuum dynamics of the Abelian gauge field, that is described by a new pair of canonical variables, is revealed. This dynamics is shown to give origin to the θ-vacuum, thus providing a field analogy of the Josephson effect. The destructive interference of the topological phases - that the fermion fields are shown to acquire - is considered as a reason for the charge screening in the two-dimensional massless QED. (author). 11 refs.

52105 (INP–1414/PS, pp. 215-232) **Asymptotic quantization of the electromagnetic field and the resulting inequality for the fine structure constant.** Staruszkiewicz, A (Uniwersytet Jagiellonski, Cracow (Poland). Inst. Fizyki). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Arguments are presented which allow to derive the inequality $0 < e^2/\hbar c < \Pi$ in a purely phenomenological way i.e. without assumptions about the dynamics of sources of the electromagnetic field. 11 refs. (author).

52106 (ITP–88-121) **Soliton model for elementary electric charge.** Chepilko, N.M.; Kobushkin, A.P. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 17p. Order Number DE91602739. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The existence and topological stability of three-dimensional solitons in Klein-Gordon field electrodynamics are proved. The central-symmetric solution to field equations, which can be interpreted as soliton model of elementary electric charge with zero spin, is constructed. The electrostatic soliton rotation is shown to result in the charge having its own magnetic-dipole field. 9 refs.; 2 figs.

52107 (LAFI–145) **Coulomb interaction in the supermultiplet basis.** Ruzha, Ya.Kh.; Guseva, T.V.; Tamberg, Yu.Ya.; Vanagas, V.V. AN Latvijskoj SSR, Riga (USSR). Inst. Fiziki. 1989. 37p. Order Number DE91602740. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An approximate expression for the matrix elements of the Coulomb interaction operator in the supermultiplet basis has been derived with the account for the orbitally-nonsymmetric terms. From the general expression a simplified formula for the Coulomb interaction energy has been proposed. On the basis of the expression obtained the contribution of the Coulomb interaction to the framework of a strongly restricted dynamic model in the light ($4 \leq A \leq 40$) and heavy ($158 \leq A \leq 196$) nuclei region has been studied. 19 refs.; 4 tabs.

52108 (PHE–86-13, pp. 31-45) **Non-abelian gauge theory in a constant homogeneous background.** Kaiser, H.J. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik); Wieczorek, E.; Scharnhorst, K. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Radiative corrections in constant homogeneous background fields in non-abelian gauge theories are studied beyond the 1-loop approximation. In this frame the gluon propagator in constant homogeneous background fields is derived in form of a modified real Euclidean proper-time representation. The propagator obtained here is better suited to evaluate radiative corrections and to disentangle real and imaginary parts in the effective potential of the gauge field sector. In the resulting expression for the effective potential all the phase factors drop out and the imaginary part can be easily expressed in terms of the renormalized gluon tensor. This finally allows to discuss the physical meaning of the imaginary part from a new point of view.

52109 (PHE–86-13, pp. 74-84) **Phase transition in the infinite-dimensional Z(Q)-symmetric models.** Akheyan, A.Z. (Erevanskij Fizicheskij Inst., Erevan (USSR)); Ananikyan, N.S. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The critical behaviour of the Q-component Potts model on a Bethe lattice is studied. Critical temperatures $T_c^{(1)}$ of the II order phase transition and $T_c^{(2)}$, below which a spontaneous magnetization exists, are found. These temperatures coincide for the ising model Q = 2. Critical exponents β and δ, and also scaling function at $T \approx T_c^{(1)}$ are calculated. The obtained critical exponents confirm the mean field results for the ising model and are $\beta = 1/2$, $\delta = 3$, respectively. Their values are independent of Q. It is shown that pure gauge models have only I order phase transitions, but introducing matter fields, interacting with gauge ones it is possible to obtain the II order transition. (author).

52110 (PHE–86-13, pp. 85-88) **Compact Lie algebras do not admit constant Yang-Mills potentials.** Schimming, R. (Greifswald Univ. (German Democratic Republic)). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Considering constant gauge potentials over a Euclidean or Lorentzian n-dimensional vector space with values in some compact Lie algebra the Yang-Mills equations force the gauge field to be Abelian. This theorem is proved and applied to the classical Lie algebras as well as to the exceptional compact Lie algebras. Two examples are given. It is concluded that non-Abelian constant Yang-Mills potentials exist if nilpotent Lie algebras are permitted.

52111 (PHE–86-13, pp. 89-100) **Strings in general background fields.** Dorn, H. (Humboldt-Universitaet, Berlin (German Democratic Republic). Sektion Physik); Otto, H.J. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

We give a short review of available methods to derive effective actions describing the massless excitations of strings. Special emphasis is given to the β-function approach and to our own investigations of the open string case within this framework. (author).

52112 (PHE–86-13, pp. 101-120) **Calculation of the static inter-quark potential in the string model in the timelike gauge.** Nesterenko, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Quantum theory of the relativistic string with fixed ends is constructed in the timelike gauge. There are no tachyon states and constraints on the dimension of space-time. The string generates the static interquark potential $V(R) = \sqrt{\gamma^2 R^2} + \epsilon_0$, where ϵ_0 is a free parameter determined in the experiment. (author).

52113 (PHE–86-13, pp. 121-135) **Status of scaling in lattice gauge theory.** Gutbrod, F. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Recent Monte Carlo results relevant for scaling properties of SU(2) lattice gauge theory are presented. Special emphasis is laid on the scaling violations visible in improved Creutz ratios and in the static qq-bar-potential in SU(2). (author).

52114 (PHE–86-13, pp. 136-146) **Vortices on the two-dimensional lattice.** Grunewald, S. (Humboldt-Universitaet, Berlin (German Democratic Republic). Sektion Physik); Mueller-Preussker, M.; Ilgenfritz, E.M. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

For the 2 D Abelian Higgs model on the lattice we identify (multi-) vortex configurations by relaxation of Monte Carlo equilibrium configuration. (author).

52115 (PHE–86-13, pp. 147-160) **The description of the deuteron as a six-quark system in QCD.** Larin, S.A. (AN SSSR, Moscow (USSR). Inst. Yadernykh Issledovanij); Matveev, V.A. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The QCD sum rule method is applied to studying the mass spectrum of six-quark dibaryon states with quantum numbers of the deuteron. The deuteron mass obtained agrees with the experimental value within the precision of the method. We also study the sum rule for the channel with quantum numbers of the so called virtual level with 'binding energy' $\epsilon = 0.07$ MeV. (author).

52116 (PHE–86-13, pp. 161-168) **Gauge invariance of the first-quantized bosonic string.** Weigt, G. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The gauge invariance of the free closed bosonic quantum string at noncritical dimensions can be seen as a cancellation of anomalies among the string coordinates, the ghosts, and the Liouville field. (author).

52117 (PHE–86-13, pp. 169-183) **Regularized bosonic string theory.** Ambjoern, J. (Niels Bohr Inst., Copenhagen (Denmark)); Durhuus, B. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

A euclidean invariant theory of random surfaces is defined and it is shown how it might be a regulated version of the bosonic string. (author).

52118 (PHE–86-13, pp. 204-205) **Symmetry in stochastic quantification with regularizing noise.** Kirschner, R. (Leipzig Univ. (German Democratic Republic). Sektion Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

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52119 (PHE–86-13, pp. 271-291) **Hamiltonian formulation of gauge theories with an explicit solution of the constraint equation.** Ilieva, N.P. (Joint Inst. for Nuclear Research, Dubna (USSR)); Nguyen Suan Han; Pervushin, V.N. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

A gauge-invariant and relativistic-covariant canonical quantization scheme is suggested based on an explicit solution of the constraint equations. The corresponding functional integral is constructed that leads the Green one-particle functions with physically correct (poles) analytical properties. Possible solutions of the problems of gauge ambiguities and quark confinement are discussed in that approach. (author).

52120 (PHE–86-13, pp. 292-305) **Low-energy predictions from modern chiral lagrangians.** Bel'kov, A.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij); Ebert, D.; Pervushin, V.N. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The structure of modern chiral meson Lagrangians, like the kinetic term, the extended Skyrme term, the symmetry breaking term, and the anomalous Wess-Zumino term, is investigated. The used approach based on a QCD-motivated quark model has the advantage that the normalizations of all meson couplings and decay constants can be fixed. Low-energy predictions of modern quark-based effective Lagrangians are discussed for scattering lengths of pion-pion and pion-kaon scattering, the decay $\eta' \to \eta 2\pi$ and the vector form factor of K_{l4} decay. The agreement with experiments is generally encouraging.

52121 (PHE–86-13, pp. 346-351) **BRST cohomology for SU(2) Yang-Mills theory developed around a BPST instanton.** Muelsch, D. (Leipzig Univ. (German Democratic Republic). Sektion Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The study show how the horizontality method for obtaining BRST transformations rules and an invariant motion may be applied to the case of SU(2) Yang-Mills theory developed around a BPST instanton solution in Euclidean four-space M. In this way, the anomalies can be found non-perturbatively using recently introduced methods which provide a systematic algorithm for computing anomalies.

52122 (PHE–86-13, pp. 352-360) **The Gaussian effective potential.** Pohle, H.J. (Leipzig Univ. (German Democratic Republic). Sektion Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Nonlinear field theoretical models are studied by means of variational methods. The results obtained from these variational calculations are generalized and renormalized by the help of the Gaussian effective potential. This method is applied to ϕ^4-field theory and to pure Yang-Mills theory.

52123 (PHE–86-13, pp. 361-382) **The confusion mechanism and the heterotic string.** Bennett, D.L. (Royal Danish College of Pharmacy, Copenhagen (Denmark)); Nielsen, H.B.; Brene, N.; Mizrachi, L. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The confusion mechanism introduced earlier in connection with the gauge glass model is here discussed in the context of field theories involving symmetry groups which have outer automorphisms. The heterotic string with an $E_8 \times E_8$ symmetry may be influence by confusion with the result that only one E_8 group survives and the shadow world disappears. (author).

52124 (PHE–86-13, pp. 383-393) **Number of generations related to coupling constants by confusion.** Bennett, D.L. (Royal Danish College of Pharmacy, Copenhagen (Denmark)); Nielsen, H.B.; Picek, I. Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

In the context of random dynamics, the mechanism of confusion is used to obtain a relation between the number of generations and standard model coupling constants. Preliminary results predict the existence of four generations. (author).

52125 (PHE–86-13, pp. 394-405) **Reduction of coupling and its application.** Sibold, K. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

After explaining the concept of reduction of couplings we present results of two important applications. One is reduction in the standard model, the other is a finiteness criterion in supersymmetric Yang-Mills theories. (author).

52126 **Quarks and the spin of the proton for pedestrians.** Lipkin, H.J. (Dept. of Nuclear Physics, Weizmann Institute of Science, Rehovot 76100 (IL)). pp. 54-58 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

The analysis of the EMC result on the quark contribution to the spin of the proton has caused considerable confusion and is unnecessarily complicated because of the use of SU(3) flavor symmetry to provide input on the proton wave function from hyperon decays. The basic physics can be seen by noting a clear inconsistency between the known result of the axial vector contribution to nucleon beta decay and the conventional quark-parton interpretation of the EMC result.

52127 **Resonance photo and electroproduction as a probe of QCD.** Close, F.E. (Oak Ridge National Lab., Oak Ridge, TN (US)). pp. 67-85 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 DOE Contract AC05-84OR21400. (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

Analogies have been drawn between QCD where quarks build up hadrons, which in turn build up nuclei, and QED where electrons build up atoms, which in turn build up molecules. The author discusses the issue of creating a quark theory of the nucleus in QCD by analogy with the way electrons build up molecules in QED. In QED the first step has been achieved, namely understanding atoms in terms of their electronic structure, but molecular structure in QED is only understood in rather simple cases. In QCD the situation is even worse, in that researchers haven't even achieved the first step, namely in understanding how hadrons are built from quarks.

52128 **Indirect searches for very heavy quarks.** Bigi, I.I. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). pp. 75-81 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The N.Y. Academy of Sciences, New York, NY (USA) (1987). pp. 365 DOE Contract AC03-76SF00515. (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the history of K decay studies and their indications that new physics can be found in an indirect way. An understanding of the B meson wave function is presented.

52129 **Experimental review of exclusive processes in two photon reactions.** Ronan, M.T. (Lawrence Berkeley Lab., Berkeley, CA (US)). pp. 51-80 of Proceedings of the VIIth international workshop on photon-photon. Courau, A.; Kessler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 485 DOE Contract AC03-76SF00098. (CONF-8604238–: 7. international workshop on photon-photon collisions, Paris (France), 1-5 Apr 1986).

Recent experimental results on exclusive final states produced in photon-photon interactions are reviewed. Comparisons between experiments and with perturbative QCD calculations are made for meson and baryon pair production. New results on vector meson pair production and production of multiparticle final states are summarized.

52130 **Two-photon exclusive processes in quantum chromodynamics.** Brodsky, S.J. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). pp. 81-100 of Proceedings of the VIIth international workshop on photon-photon. Courau, A.; Kessler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 485 DOE Contract AC03-76SF00515. (CONF-8604238–: 7. international workshop on photon-photon collisions, Paris (France), 1-5 Apr 1986).

QCD predictions for $\gamma\gamma$ annihilation into single mesons, meson pairs, and baryon pairs are reviewed. Two-photon exclusive processes provide the most sensitive and practical measure of the distribution amplitudes, and thus a critical confrontation between QCD and experiment. Both the angular distribution and virtual photon mass dependence of these amplitudes are sensitive to the shapes of the $\phi(x,Q)$. Novel effects involving the production of $qq\bar{q}$ states at threshold are also discussed, and a new method is presented for systematically incorporating higher-order QED corrections on $\gamma\gamma$ reactions.

52131 Eta photoproduction in the S11 region. Benmerrouche, M. (Dept. of Physics, Rensselaer Polytechnic Institute, Troy, NY (US)); Mukhopadhyay, N.C. pp. 199-204 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

The eta photoproduction reaction is analyzed with a view to examine the γNS_{11} resonant amplitude. The role of the nonresonant background is emphasized. The analysis is based on the effective Lagrangian formalism and includes contributions form the s- and u-channel nucleon, t-channel vector meson and s- and u- channel S_{11} resonance exchanges. As in the case of πo photoproduction, there is a large difference between pseudoscalar (PS) and pseudovector (PV) nucleon Born terms and the ρ and ω contributions can be substantial. The authors discuss the E_{0+} (E1) amplitude and the corresponding partial cross-section. The results are compared with the isobar model analysis.

52132 Dynamics of symmetry breaking in strong coupled QED. Bardeen, W.A. (Fermi National Accelerator Lab., Batavia, IL (USA)). pp. 110-126 of New trends in strong coupling gauge theories. Bando, M.; Muta, T.; Yamawaki, K. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 350 (CONF-8808309–: International workshop on new trends in strong coupling gauge theories, Nagoya (Japan), 24-27 Aug 1988).

The author reviews the dynamical structure of strong coupled QED in quenched, planar limit. The symmetry structure of this theory is examined with reference to the nature of both chiral and scale symmetry breaking. The renormalization structure of the strong coupled phase is analyzed. The compatibility of spontaneous scale and chiral symmetry breaking is studied using effective Lagrangian methods.

52133 A new phase of QED and narrow peaks in heavy-ion collisions. Caldi, D.G. (Connecticut Univ., Storrs, CT (USA). Dept. of Physics). pp. 198-205 of New trends in strong coupling gauge theories. Bando, M.; Muta, T.; Yamawaki, K. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 350 (CONF-8808309–: International workshop on new trends in strong coupling gauge theories, Nagoya (Japan), 24-27 Aug 1988).

The authors review the experimental evidence for narrow peeks in e^+e^- coincidence data from low-energy collisions of heavy ions and various theoretical explanations. They concentrate on the scenario that the narrow peaks are well explained by composite states of e^+e^- in a new phase of QED with chiral symmetry spontaneously broken. Evidence for a new phase lattice and continuum studies is discussed, as well as the question of whether background fields can induce the phase transition. The spectrum obtained from a strong-coupling calculation in the new phase is given, which agrees well with the experimental peaks. A model for gamma-ray busts based on the new phase is also discussed.

52134 Fourth-family quark masses and the Kobayashi-Maskawa phenomenology from the regularities in the structure of quark mass matrices. Shin, M. (Physics Dept., Brown Univ., Providence, RI (US)). pp. 116-121 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper discusses the theoretical expectations on the hypothetical fourth-family of quarks implied by the regularities present in the quark mass matrices. In the meantime, The author encourages colleagues with theoretical predilections to test the KM mixing angles predicted by the structures presented by applying them to all aspects of KM phenomenologies, and narrow down the allowed mass ranges (m_b, m_t). A review is offered on two recent theoretical ides that successfully relate the observed KM angles to the quark mass ratios.

52135 Constraints and speculations on fourth-generation physics. Marciano, W.J. (Physics Dept., Brookhaven National Lab., Upton, NY (US)). pp. 180-185 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper describes some low-energy constraints on the properties of a fourth-generation and point out some implications it might have for neutrino oscillations. The author gives some results of a recent global analysis of weak neutral current phenomenology that provide constraints on fourth-generation masses. Bounds on fourth-generation quark mixing from charged current unitarity are surveyed. The author speculates about some properties a fourth-generation neutrino might exhibit, with emphasis on neutrino oscillations in matter.

52136 Holonomy anomalies. Bagger, J. (Lyman Lab. of Physics, Harvard Univ., Cambridge, MA (US)); Nemeschansky, D.; Yankielowicz, S. pp. 197-204 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 DOE Contract AC03-76SF00515. Contract NSF-PHY-82-15249. (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper gives a unified picture of sigma model anomalies. The authors show how the anomalies can be canceled by Chern-Simons terms built out of appropriate connections w^1. When generalized 't Hooft conditions are satisfied, the Chern-Simons term can be pulled back to an integral over spacetime, and the effective action is well-defined.

52137 A physical interpretation of the 3rd cocycle in the group cohomology of nonAbelian gauge theories. Grossman, B. (Rockefeller Univ., New York, NY (USA)). pp. 169-176 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper discusses how the extension of the loops in the quotient bundle by loops in the group Ω is related to a possible string theory extension of gauge theories. The central extensions of the loops in the Lie algebra are classified by the Kac-Moody Lie algebras whose representations determine string theories. These exponentiate to a group when the coefficient of the central extension satisfies a quantization condition. The author reports that this could perhaps be obtained by quantizing the stringlike singularities between magnetic monopoles with 1/N times the usual Dirac charge.

52138 Color magnetism and delta photoproduction. Mukhopadhayay, N.C. (Dept. of Physics, Rensselaer Polytechnic Institute, Troy, NY (US)). pp. 205-234 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

Just as the spectroscopy of atomic levels teaches us about the quantum electrodynamics, the dynamics of interaction between the leptons and the nucleus, so is the spectroscopy of excited baryons a powerful tool to study quantum chromodynamics (QCD), the dynamics of interacting quarks and gluons that make hadrons. One of the most prominent of these excited baryons is the delta (1232) resonance. The progress made in the electromagnetic excitation of this resonance over three decades is summarized, with emphasis on the recent progress in the ways of extracting the nucleon to delta electromagnetic transition amplitudes from existing experiments on photoproduction of pions.

52139 Problems of describing spin −3/2 baryon resonances in the effective lagrangian theory. Davidson, R.M. (Dept. of

Physics, Rensselaer Polytechnic Institute, Troy, NY (US)); Benmerrouche, M.; Mukhopadhyay, N.C. pp. 293-297 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

The authors investigate several theoretical issues associated with the treatment of the spin - 3/2 baryons in the effective Lagrangian theory. These are: form of the spin - 3/2 particle propagator; off-shell parameters involving the spin - 3/2 field; strategies of implementing gauge invariance; unitarity. They comment on previous works. The authors' experience on the delta (1232) resonance is invoked as a concrete example of dealing with these problems. Examples of some related problems appear in theories of massive vector and spin - 3/2 particles, in pion decay and supersymmetry respectively.

52140 Dijet angular distribution and multijet topology at square root of s = 1.8 TeV. Patrick, J.F. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 217-226 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The distribution in center of mass scattering angle θ^* of the jets in two jets events and of the leading jet in 3 jet events has been measured in proton - antiproton collisions at square root s = 1.8 TeV using the CDF detector at the Fermilab Tevatron Collider. The results are compared to QCD predictions. A preliminary study of the topology of 4 jet events has been made. The data has been compared 4 jet events generated by ISAJET and to a model for multiparton scattering constructed by merging 2 jet events generated by ISAJET.

52141 Classical geometrical interpretation of ghost fields and anomalies in Yang-Mills theory and quantum gravity. Thierry-Mieg, J. (Lawrence Berkeley Lab., CA (USA)). pp. 239-246 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper discusses the reinterpretation of the BRS equations of Quantum Field Theory as the Maurer Cartan equation of a classical principal fiber bundle leads to a simple gauge invariant classification of the anomalies in Yang Mills theory and gravity.

52142 Aspects of superstring theory. Green, M.B. (California Inst. of Tech., Pasadena, CA (USA)). pp. 263-275 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper outlines features of superstring theories which have arisen in the course of their development. These include: a discussion of the covariant action that describes the classical dynamics of a superstring in a geometrical manner; an outline of lightcone-gauge superstring field theory with an explanation of the absence of higher-order contact interactions in superstring theories; and a derivation of Yang-Mills field theory as the low-energy limit of the field theory of open superstrings directly from the stringfield action.

52143 The strongly coupled standard model. Farhi, E. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Center for Theoretical Physics). pp. 326-330 of New trends in strong coupling gauge theories. Bando, M.; Muta, T.; Yamawaki, K. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 350 (CONF-8808309–: International workshop on new trends in strong coupling gauge theories, Nagoya (Japan), 24-27 Aug 1988).

This paper reports on the strongly coupled standard model or SCSM. The author emphasizes the dynamical assumptions which must be in order for this model to work. The model begins with the standard weak interaction Lagrangian based on $SU(2)_L \times U(1)_Y$.

52144 The CDF direct photon analysis. Blair, R. (Argonne National Lab., Argonne, IL (US)). pp. 361-371 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

Using data from $\bar{p}p$ collisions observed in the CDF detector at square root s of 1.8TeV, a sample of events are selected which have calorimetry and tracking consistent with a single isolated photon produced in the central rapidity range $(-.9<\eta<.9)$ with $P_T>15$GeV. In the P_T range below 30 GeV, the lateral shape of the shower measured at 6 radiation lengths is used to evaluate the fraction of events which are actually isolated neutral hadrons. The photon cross section versus P_T is compared with that expected from QCD plus lower energy collider measurements.

52145 Are fourth-generation quarks integrally charged. Pakvasa, S. He, X.G. (Dept. of Physics and Astronomy, Univ. of Hawaii at Manoa, Honolulu, HI (US)); Sugawara, H. pp. 332-336 of The fourth family of quarks and leptons: Volume 518. Cline, D.B.; Soni, A. The New York Academy of Sciences, New York, NY (USA) (1987). pp. 365 (CONF-870278–: 1. international symposium on the fourth family of quarks and leptons, Santa Monica, CA (USA), 26-28 Feb 1987).

This paper reviews a novel way of implementing generation symmetry before grand unification in which the unification scale can be as high as the Planck scale (and the correct $\sin^2\theta_W$ prediction is preserved). The authors state that in the simplest model of this kind, corresponding to a low-energy gauge group $SU(2)_L \times SU(2)_R \times SU(3)_c \times SU(4)_G$, there are striking experimental signatures from production and decay of integer-changed fourth-generation quarks. They describe the consequences of a scheme in which the gauge is enlarged to $SU(2)_L \times SU(2)_R \times SU(3)_c \times SU(5)_G$ and the fourth-generation quarks are normal (while the fifth-generation quarks carry charges (−1/6, −7/6)).

52146 Production and phenomenology of glueballs. Chan, C.S. (City College of New York, New York, NY (US)); Lindenbaum, S.J. pp. 439-470 of Excited Baryons 1988. Adams, G.; Mukhopadhyay, N.C.; Stoler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1989). pp. 565 (CONF-8808198–: Topical workshop on excited baryons, Troy, NY (USA), 4-6 Aug 1988).

After a brief introduction, the current status of the prominent glueball candidates are reviewed. In particular, the authors present a partial wave analysis of 6658 events of the reaction $\pi^-p \rightarrow \phi n$ at 22 GeV/c. The data analysis reveals three resonances $_{gT}(2010)$, $_{gT'}(2300)$ and $_{gT''}(2340)$, all with the same quantum numbers $I^GJ^{PC} = 0^+2^{++}$ which comprise virtually all the production cross section.

52147 Top quark mass in grand unified theories with intermediate scales. Shafi, Q. (Delaware Univ., Newark, DE (USA). Bartol Research Foundation). pp. 458-459 of Test of electroweak theories: Polarized processes and other phenomena. Lynn, B.W.; Verzegnassi, C. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 461 (CONF-8506204–: Workshop on tests of electroweak theories, polarized processes and other phenomena, Trieste (Italy), 10-12 Jun 1985).

This paper discusses the relation which predicts a top quark mass close to 40 GeV and is derived in the context of SO(10)(and E_6) grand unified theories with suitable intermediate scales.

52148 Applications of amplitude factorization to γ production of vector meson pairs. Brodsky, S.J. (Stanford Linear Accelerator Center, Stanford Univ., CA (US)); Meshkov, S. pp. 462 of Proceedings of the VIIth international workshop on photon-photon. Courau, A.; Kessler, P. World Scientific Pub. Co., Teaneck, NJ (USA) (1986). pp. 485 (CONF-8604238–: 7. international workshop on photon-photon collisions, Paris (France), 1-5 Apr 1986).

A crossing symmetric description of the $\gamma\gamma$ production of $\rho^0\rho^0$ and other vector meson pairs is formulated. The authors use light cone extension of the Yennie shrinking photon slope parameterization of electroproduction and threshold photoproduction which interpolates between QCD pointlike behavior and VMD. The model predicts a flat $\cos\theta_{CM}$ production distribution near threshold for $\gamma\gamma \rightarrow \rho^0\rho^0$. The distribution becomes forward peaked as $W_{\gamma\gamma}$ increases.

52149 Effective actions, decoupling and anomalies in chiral gauge theories. D'Hoker, E. (Columbia Univ., New York, NY

(USA). Dept. of Physics); Farhi, E. pp. 477-482 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper shows that the Wess-Zumino term is a calculable consequence of decoupling a fermion in a chiral gauge theory. An anomaly free theory remains gauge invariant after decoupling a fermion. Decoupling alters the statistics and quantum numbers of stable solitons. The authors state that if originally no stable solitons are present, decoupling may create stable solitons.

52150 **Fractional charge in a nut-shell.** Boyanovsky, D. (Stanford Univ., CA (USA)); Blankenbecler, R. pp. 427-433 of Proceedings of a symposium on anomalies geometry topology. Bardeen, W.A.; White, A.R. World Scientific Pub. Co., Teaneck, NJ (USA) (1985). pp. 558 (CONF-8503141–: Symposium on anomalies, geometry and topology, Argonne, IL (USA), 28-30 Mar 1985).

This paper presents a study of physics of charge fractionalization using simple methods. The strategy is to count the number of states of the theory will solitons relative to the same theory with trivial background fields. The interplay between high and low energy contributions is exposed and the topological properties clarified.

52151 **Heavy quark production at collider energies.** Ellis, R.K. (Fermi National Accelerator Lab., Batavia, IL (US)). pp. 639-660 of Proceedings of the 7th topical workshop on proton-antiproton collider physics. Raja, R.; Tollestrup, A.; Yoh, J. World Scientific Pub. Co., Teaneck, NJ (USA) (1988). pp. 885 (CONF-8806232–: 7. topical workshop on proton-antiproton collider physics, Batavia, IL (USA), 20-24 Jun 1988).

The author reviews the theory of heavy quark production in QCD at collider energies. The most important features of the recently published results on higher order corrections to the heavy quark production cross- section are described. The phenomenological consequences of these formulae for bottom and top quark production at SpρS and Tevatron energies are presented.

52152 **Convergence radius of chiral perturbation theory in the large-N_c limit.** Hatsuda, T. (Department of Physics, State University of New York at Stony Brook, Stony Brook, NY (USA)). *Physical Review Letters (USA),* 65(5): 543-546 (30 Jul 1990). DOE Contract FG02-88ER40388.

By using a dynamical model of chiral-symmetry breaking, we demonstrate that the chiral perturbation expansion around the $SU_f(3)$-symmetric vacuum does not converge in the large-N_c limit. The convergence radius of the expansion in the strange-quark mass m_s is shown to be 30–50 MeV, which means that higher-order terms become larger as one increases the order of the expansion in the physical region (m_s~150 MeV). The first-order mass formula for the Nambu-Goldstone bosons turns out to be accidentally valid in the physical region.

52153 **$E(1420)$ meson as a $K\bar{K}\pi$ molecule.** Longacre, R.S. (Brookhaven National Laboratory, Upton, NY (USA)). *Physical Review, D (Particles Fields) (USA),* 42(3): 874-883 (1 Aug 1990). DOE Contract AC02-76CH00016.

In this article an experimental summary of the $E(1420)$ meson with $J^{PC}=1^{++}$ is presented and it is argued that the $E(1420)$ is not explained by QCD in terms of being a fundamental arrangement of quarks and gluons. We then develop a final-state rescattering mechanism based on one-particle-exchange Born terms. We sum these Born terms through a Fredholm integral equation and obtain a Fredholm determinant which shows an enhancement at the $E(1420)$ with $J^{PC}=1^{++}$. The subsequent sum of Born terms is analogous to a π orbiting in a p wave around an s-wave $K\bar{K}$ system. This represents the first example of a molecular state which is bound by color-singlet particle exchanges, as opposed to work by Weinstein and Isgur, which uses color forces to bind their molecule. A phenomenological analysis of all the latest $K\bar{K}\pi$ data arising from hadroproduction argues that the molecular picture for the $E(1420)$ is consistent. We show that if the molecular nature for the $E(1420)$ is generated by the above final-state Born terms, an exotic $K^+\bar{K}_0K^+$ $J^P=0^-$ molecule must exist at the $K\bar{K}K$ threshold.

52154 **Field-theory calculations of the pion mass to one-loop order.** Hakioglu, T. (Department of Physics, University of Arizona, Tucson, AZ (USA)); Scadron, M.D. *Physical Review, D (Particles Fields) (USA),* 42(3): 941-944 (1 Aug 1990).

We compute the pion mass to one-loop order in the SU(2) linear σ and four-fermion model field theories both in terms of the non-strange current-quark mass $\hat{m}_{cur}$. The answers in these two chiral-symmetry schemes are the same and predict $\hat{m}_{cur}\approx 34$ MeV for two quark flavors.

65 PHYSICS II

Refer also to citation(s) 50990

6510 Nuclear Physics

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52155 (BNL–45211) **New results from AGS [Alternating Gradient Synchrotron] heavy-ion experiments.** Bloomer, M.A. (Lawrence Berkeley Lab., CA (USA)); Love, W.; Waters, L. E802 Collaboration; E810 Collaboration; E814 Collaboration. Brookhaven National Lab., Upton, NY (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration; National Science Foundation; US-Japan High Energy Physics Collaboration Treaty. DOE Contract AC02-76CH00016. (CONF-900601–13: 12. PANIC international conference on particles and nuclei, Cambridge, MA (USA), 24-29 Jun 1990). Order Number DE91000906. Source: NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.

We review the most recent data from Experiments 802, 810 and 814 of the heavy-ion program at the Brookhaven Alternating Gradient Synchrotron (AGS).

52156 (DOE/ER/40150–134) **Physics program in Hall A at CEBAF.** Saha, A. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-002). Order Number DE91000428. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We present here the physics program planned for Hall A at CEBAF. It encompass exclusive as well as inclusive electromagnetic measurements requiring both high precision and accuracy. The program includes measurements of the elementary form factors of the nucleon, systematic studies of the few nucleon systems (d, ^{3,4}He), high momentum structure of nuclei, their structure at high Q^2 to look for hadronization and quark effects, spin response of nuclei via $(\vec{e}, e'\vec{p})$ reactions and the study of nuclear pion fields.

52157 (DOE/ER/40270–22) **Investigations of the structure and electromagnetic interactions of few-body systems: Progress report, 1 September 1989–31 August 1990.** Lehman, D.R. George Washington Univ., Washington, DC (USA). Sep 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER40270. Order Number DE91000675. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This progress report contains brief discussions on electromagnetic interactions and photonuclear reactions in nuclei. (LSP)

52158 (DOE/ER/40309–13) **Nuclear structure at intermediate energies: Progress report, January 1–December 31, 1990.** Bonner, B.E.; Mutchler, G.S. Rice Univ., Houston, TX (USA). Bonner Nuclear Labs. 30 Sep 1990. 71p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40309. Order Number DE91000678. Source: NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: antiproton nucleus interactions; strangeness production in heavy ion collisions; search for a J^{PC} exotic hybrid meson; the SMC experiment; pion production in $\vec{n}p$ scattering; spin transfer measurements for $\vec{n}p$ elastic scattering; pion production in $\vec{n}\vec{p}$ scattering; radiative muon capture (RMC) on hydrogen; radiative decays of low-lying hyperons;

photoproduction of jets in nuclei; cylindrical multiplicity detector; MWPC detectors and electronics; lead glass array; cylindrical wire chamber; beam calorimeter; shower counter; and muon veto hodoscope.

52159 (DOE/ER/40330–44) **Nuclear structure from radioactive decay: Annual progress report.** Wood, J.L. Georgia Inst. of Tech., Atlanta, GA (USA). School of Physics. 30 Sep 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40330. Order Number DE91000932. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report discusses the nuclear structure of the following isotopes as a result of radioactive decays: neutron-deficient iridium isotopes; neutron-deficient platinum isotopes; neutron-deficient gold isotopes; neutron-deficient mercury isotopes; neutron-deficient thallium isotopes; neutron-deficient lead isotopes; neutron-deficient promethium isotopes; and neutron-deficient samarium isotopes.

52160 (DOE/ER/40334–6) **Nuclear excitations and reaction mechanisms: Progress report, [1 August 1989–31 July 1990].** Fallieros, S.; Levin, F.S. Brown Univ., Providence, RI (USA). Dept. of Physics. 1 Aug 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40334. Order Number DE91000601. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The main theme of this report is the study and interpretation of the sequence of events that occur during the collisions of nuclear particles. Some of the processes discussed in parts A and B involve short range interactions; others involve interactions of long range. In most of part A one of the particles in the initial or in the final state (or in both) is a photon, which serves as a probe of the second particle, which may be a nucleus, a proton, a pion or any other hadron. The complexity of the processes taking place during the collisions makes it necessary to simplify some aspects of the physical problem. This leads to the introduction of modals which are used to describe a limited number of features in as much detail as possible. The main interest is the understanding of the hadronic excitations which result from the absorption of a photon and the determination of the fundamental structure constants of the target particle. In part B, all the particles are hadrons. The purpose here is to develop and apply optimal quantal methods appropriate for describing the interacting systems. Of particular interest are three-particle collision systems in which the final state consists of three free particles. Part B also considers the process of nuclear fusion as catalyzed by bound muons.

52161 (DOE/ER/40403–T2) **Experimental studies of nucleon-nucleon and pion-nucleus interactions at intermediate energies: Progress report, April 1, 1988–March 31, 1991.** New Mexico State Univ., Las Cruces, NM (USA). 1 Oct 1990. 54p. Sponsored by U.S. DOE Energy Research. DOE Contract FG04-88ER40403. Order Number DE91000605. Source: NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report summarizes the work on experimental research in intermediate energy nuclear and particle physics carried out by New Mexico State University in 1988–91. Most of these studies have involved investigations of neutron-proton and pion-nucleus interactions. The neutron-proton research is part of a program of studies of interactions between polarized nucleons that we have been involved with for more than ten years. Its purpose has been to help complete the determination of the full set of ten complex nucleon-nucleon amplitudes at energies up to 800 MeV, as well as to continue investigating the possibility of the existence of dibaryon resonances. The give complex isospin-one amplitudes have been fairly well determined, partly as a result of this work. Our work in this period has involved measurements and analysis of data on elastic scattering and total cross sections for polarized neutrons on polarized protons. The pion-nucleus research continues our studies of this interaction in regions where it has not been well explored. One set of experiments includes studies of pion elastic and double-charge-exchange scattering at energies between 300 and 550 MeV, where our data is unique. Another involves elastic and single-charge-exchange scattering of pions from polarized nuclear targets, a new field of research which will give the first extensive set of information on spin-dependent pion-nucleus amplitudes. Still another involves the first set of detailed studies of the kinematic correlations among particles emitted following pion absorption in nuclei.

52162 (GSI–90-36(prepr.)) **Reactions at tens of MeV/u and a few GeV/u: Differences and similarities.** Henning, W. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 20p. (CONF-9004248–: 2. IN2-P3-RIKEN symposium on heavy-ion collisions, Obernai (France), 9-13 Apr 1990). Order Number DE91706319. Source: NTIS (US Sales Only), PC A03/MF A01.

The increased interest in heavy-ion physics at GeV/u energies is still paralleled by intensive research at energies closer to the barrier up to tens of MeV/u. The new heavy-ion facility at GSI, consisting of the improved UNILAC and a new 2 GeV/u synchrotron SIS and the experimental storage ring ESR allow heavy-ion studies over the full energy range. An attempt is made to summarize the research proposals for these facilities in light of the differences and common aspects between the various energy regimes. (orig.).

52163 (INP–1414/PS, pp. 133-144) **Production and spectroscopy of nuclei far from stability line. Recent results obtained at the GSI on-line mass separator.** Klepper, O. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The mass-separator on-line to the heavy-ion accelerator UNILAC at GSI Darmstadt is presented. The main features of this facility are briefly described, in particular the recent development of an ion source with bunched beam release, and results from recent decay-spectroscopic measurements of mass-separated samples are given. Using fusion-evaporation reactions with ^{40}Ca and ^{58}Ni projectiles, proton-rich nuclei are studied in the fp shell, "southeast" of ^{100}Sn and "northwest" of ^{146}Gd. The comparison of the measured GT beta-decay strength may yield systematic (mass dependent) information on the quenching of proton-to-neutron transitions between spin-orbit partners in the f,g and h shells. By determining low-lying single-proton states and associated single-particle energy separations, the systematics of the N=82 single-particle energy gap beyond Z=64 is extended up to Z=69. Neutron-rich nuclei are produced and investigated over a wide range of elements between chromium and actinium using (9-15) MeV/u beams between ^{76}Ge and ^{238}U. The measured beta decay half-lives in the iron region are considerably shorter than predicted by current models. New theoretical approaches to overcome this deficiency and also the possible influence of these shorter half-lives on r-process calculations are discussed. Collinear laser spectroscopy is applied to systematically determine isotope shifts and moments for long chains of isotopes in the tin and lead region. 60 refs., 6 figs. (author).

52164 (INP–1414/PS, pp. 163-172) **"Δ"s in nuclei.** Ellegaard, C. (Niels Bohr Inst., Copenhagen (Denmark)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The excitation of Δ resonances in the charge exchange (^{3}He, t), (d-vector, ^{2}He) and heavy ion reactions are examined. 14 refs., 12 figs. (M.F.W.).

52165 (INP–1414/PS, pp. 307-308) **Delta excitation in charge exchange reactions with heavy ions.** Million, B. (Niels Bohr Inst., Copenhagen (Denmark)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number

DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The charge-exchange reactions induced by heavy ions are studied. The (p,n) and (n,p) channels are compared. (M.F.W.).

52166 (JAERI-M–90-098) **Premonochromator characteristics of Si and Ge crystals for nuclear Bragg scattering.** Harami, Taikan (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1990. 83p. Order Number DE91713053. Source: NTIS (US Sales Only), PC A05/MF A01.

The use of monochromator plays an important role as monochromatizing the photon from a facility having an electron storage ring to a narrow band width about the wavelength determined by the Bragg condition. This paper describes the dynamical diffraction formulae and collects the characteristics data of premonochromators of Si and Ge crystals for nuclear Bragg scattering. The numerical studies show the following data. (1) Reflectivity, Bragg reflection width, energy resolution and integral reflecting power for the various reflections of Si and Ge crystals at the photon with the resonance excitation energy of the Moessbauer nuclei of ^{181}Tm(6.21 keV), ^{169}Tm(8.42 keV), ^{57}Fe(14.41 keV), ^{119}Sn(23.87 keV) and ^{238}U(44.70 keV). (2) Tables of susceptibilities and figures of rocking curves for the various reflections of Si and Ge crystals. (author).

52167 (LBL–29445) **Transuranium elements: A half century.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). Aug 1990. 69p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900846–2: International symposium to commemorate the 50th anniversary of discovery of transuranium elements, Washington, DC (USA), 26-31 Aug 1990). Order Number DE91000226. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report discusses the discovery of all transuranium elements over the past fifty years. (LSP)

52168 (ORNL/FTR–3733) **[Work on the L* experiment]: Foreign trip report, August 15, 1990–August 31, 1990.** Plasil, F. Oak Ridge National Lab., TN (USA). 10 Sep 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000387. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler spent eleven intense days at CERN, Switzerland. His time was divided between daytime, when he worked mainly on L* issues, and evenings/nights, when he performed shift work during the current run of the WA80 collaboration. It was decided to reduce the size and cost of the proposed L* experiment. Strategy for SSC subsystem proposals was discussed, and several relevant decisions were made.

52169 (ORNL/FTR–3743) **[The 1990 run of the WA80 experiment]: Foreign trip report, July 26–September 4, 1990.** Young, G.R. Oak Ridge National Lab., TN (USA). 18 Sep 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000386. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler spent six weeks at CERN participating in the 1990 run of the WA80 experiment. The traveler concentrated on trigger electronics for the first two weeks and on operation of the experiment for much of the next four. New electronics designed at ORNL for reading out the new BGO spectrometer were tested with the BGO in beam. Improvements were made, in collaboration with the ORNL engineers who designed the electronics. Plans were made for constructing the electronics in large quantities. Conversations were had with other members of WA80 about the analysis of results from this year's run and our plans for the 1991/1992 runs proposed for CERN. Lengthy conversations were had about the draft of a first paper concerning limits on direct photon production. Finally, the traveler attended an all-day session of the dilepton working group chartered to consider dilepton and photon experiments using heavy-ion beams in CERN's to-be-proposed Large Hadron Collider (LHC). At this meeting the traveler presented recent results from the group working on such a proposal for RHIC and updated his earlier presentation of June 1990 in this working group.

52170 (UCRL-JC–104781) **J/ψ suppression: Catching up with the comovers.** Vogt, R. (Lawrence Livermore National Lab., CA (USA)); Gavin, S. Lawrence Livermore National Lab., CA (USA). 27 Aug 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (HU-TFT–90-57;CONF-900570–12: 8. international conference on ultrarelativistic nucleus-nucleus collisions: Quark Matter '90, Menton (France), 7-11 May 1990). Order Number DE91000811. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The combined role of inelastic scattering with nucleons and comoving secondary particles in J/ψ suppression is explored. An analysis of the latest FNAL and CERN data suggests that the high-density comover contribution emerges with increasing incident energy and A.

6511 Experimental Techniques

52171 (LA-UR–90-3253) **Bayesian spectral analysis of reflectivity data.** Sivia, D.S.; Hamilton, W.A.; Smith, G.S. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9007172–1: MAXENT '90: maximum entropy workshop, Laramie, WY (USA), 30 Jul - 3 aug 1990). Order Number DE91000215. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The analysis of neutron and x-ray reflectivity data to obtain scattering-length density profiles is akin to the notorious phaseless Fourier problem, well-known in many fields such as crystallography. Current methods of analysis culminate in the refinement of a few parameters of a functional model, and are often preceded by a long and laborious process of trial-and-error. A discussion of the use of maximum entropy for obtaining "free-form" solutions of the density profile, as an alternative to the trial-and-error phase when a functional model is not available, and the suggestion for a novel experimental procedure designed to alleviate the ambiguity problems inherent in traditional reflectivity measurements, are given in Sivia et al. (1990). In this paper we consider the Bayesian spectral analysis approach, which is appropriate for optimising the parameters of a simple (but adequate) type of model when the number of parameters is not known. 8 refs., 3 figs.

52172 (LA-UR–90-3346) **High resolution inelastic gamma-ray measurements with a white neutron source from 1 to 200 MeV.** Nelson, R.O.; Laymon, C.M.; Wender, S.A. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-901116–1: 11. international conference on the application of accelerators in research and industry, Denton, TX (USA), 5-8 Nov 1990). Order Number DE91000173. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Measurements of prompt gamma rays following neutron-induced reactions have recently been made at the spallation neutron source at the WNR target area of LAMPF using germanium detectors. These experiments provide extensive excitation function data for inelastic neutron scattering as well as for other reactions such as (n,α), (n,nα), (n,p), (n,np), (n,nnp) and (n,xn) for $1 \leq x \leq 11$. The continuous energy coverage available from 1 MeV to over 200 MeV is ideal for excitation function measurements and greatly extends the energy range for such data. The results of these measurements will provide a database for interpretation of gamma-ray spectra from the planned Mars Observer mission, aid in radiation transport calculations, allow verification of nuclear reaction models, and improve the evaluated neutron reaction data base.

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

Refer also to citation(s) 51494, 51496

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

52173 (INS–834) **Nuclear Landau-Zener phenomena and the fusion cross sections in the system $^{13}C + ^{16}O \rightarrow ^{12}C +$**

^{17}O. Imanishi, B.; Oertzen, W. von. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1990. 11p. Order Number DE91713084. Source: NTIS (US Sales Only), PC A03/MF A01.

Reaction mechanism of the system $^{13}C+^{16}O$-$^{12}C+^{17}O$ is investigated with the use of the nucleon molecular-orbital model in the framework of the orthogonalized coupled-reaction-channel (OCRC) theory. The adiabatic potentials obtained are quite different from the diagonal potentials of the original OCRC basis. The Landau-Zener radial coupling explains the backward enhancement of measured differential cross sections of the transfer reaction $^{13}C(^{16}O, ^{17}O)^{12}C$. In the OCRC calculation the fusion cross sections of the channel $^{13}C+^{16}O$ is enhanced at low bombarding energies, in agreement with the experimental data. (author).

52174 (LUNFD6-NFFR-1009-1-142-1990) **The (γ, p) reaction in light nuclei at intermediate energies.** Nilsson, Dahn. Lund Univ. (Sweden). Dept. of Nuclear Physics. May 1990. 27p. Order Number DE91603164. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The (γ, p) reaction has been studied in the nuclei ^{6}Li, ^{9}Be, ^{12}C, ^{16}O, ^{27}Al and ^{40}Ca, with photon energies around 61 and 77 MeV. The photon tagging technique was used to achieve quasi-monochromatic photons. The protons were detected with a high energy resolution Si-Ge detector telescope, allowing for separation and identification of several low lying excited states in the daughter nuclei. With the same experimental setup also the (γ, d) reaction in ^{6}Li was studied. Data are compared with results from analogue reactions such as (e, e'p) and (π, NN). The results are mainly discussed in terms of photon absorption on single nucleons versus absorption on correlated nucleons. Experimental evidence indicates that photon adsorption on T=1 neutron-proton pairs is possible process, in contrast to the usual assumption in quasideuteron models that only adsorption on T=0 n-p pairs need to be considered. The (γ, p) and (γ, d) data on ^{27}Al and ^{40}Ca are also compared to results from pre-equilibrium calculations, where it is shown that the initial doorway configuration is a 2p-1h configuration.

52175 Isovector effective interactions from $^{14}C(p,n)^{14}N$ studies between 500 and 800 MeV. Sugarbaker, E. (Department of Physics, The Ohio State University, Columbus, OH (USA)); Marchlenski, D.; Taddeucci, T.N.; Rybarcyk, L.J.; McClelland, J.B.; Carey, T.A.; Byrd, R.C.; Goodman, C.D.; Huang, W.; Rapaport, J.; Mercer, D.; Prout, D. *Physical Review Letters (USA)*, 65(5): 551-554 (30 Jul 1990).

Cross sections at 0° for the pure Fermi (0^+, 2.31, MeV) and Gamow-Teller (1^+, 3.95 MeV) states in the $^{14}C(p,n)^{14}N$ reaction have been measured at E_p=494, 644, and 795 MeV using the LAMPF neutron time-of-flight facility with a new 617-m neutron flight path. The measured cross sections per unit transition strength, $\hat{\sigma}$, provide a measure of the isovector spin-flip and non-spin-flip central components of the effective nucleon-nucleon interaction. Cross sections and the ratio $R^2=\hat{\sigma}_{GT}/\hat{\sigma}_F$ are compared to lower-energy measurements and to calculations using a free *NN t* matrix.

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

Refer also to citation(s) 52174

52176 Particle-γ correlation determination of static quadrupole moments. Gross, E.E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6368 (USA)); Hensley, D.C.; Beene, J.R. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): R471-R474 (Aug 1990). DOE Contract AC05-84OR21400.

A complete particle-γ-ray angular correlation has been measured for the decay of the first 2^+ state of ^{24}Mg excited by ^{24}Mg(200 MeV)+^{208}Pb. The particle-γ-ray correlation, expressed as alignment tensors, proves to be particularly sensitive to the static quadrupole moment of the 2_1^+ state. The derived value of the 2_1^+ static quadrupole moment is Q_2=(−29±3) efm^2 which is (1.56±0.16) times larger than the rotational value.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

52177 (CONF-9006281-1-Vugraphs) **Two-proton correlations from the ^{58}Ni + ^{58}Ni reaction at $E_{inc} \simeq$ 876.5 MeV.** Korolija, M. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)); Shapira, D.; Del Campo, J.G.; Kim, H.J.; Teh, K.; Shea, J.Y. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Particle correlations and interferometry in nuclear collisions; Nantes (France); 28-30 Jun 1990. Order Number DE91000716. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The enhancement in the p-p correlation function from the ^{58}Ni + ^{58}Ni reaction at E_{inc} = 876.5 MeV is interpreted as a result of the interaction of the emitted protons in the final state. The p-p correlation function has been found to decrease very rapidly with the increase of the relative angle between the fragment and the two-proton c.m. velocities. This causes the extracted p-p correlation function to be dependent on the kinematics of the measurements. The deduced average particle emission times are in the range of 5 − 6 × 10^{-22} s.

52178 (ORNL/TM-11671) **Cross sections for production of 70 discrete-energy gamma rays created by neutron interactions with ^{56}Fe for E_n to 40 MeV: Tabulated data.** Dickens, J.K.; Todd, J.H.; Larson, D.C. Oak Ridge National Lab., TN (USA). Sep 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000871. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Inelastic and nonelastic neutron interactions with ^{56}Fe have been studied for incident neutron energies between 0.8 and 41 MeV. An iron sample isotopically enriched in the mass 56 isotope was used. Gamma rays representing 70 transitions among levels in residual nuclei were identified, and production cross sections were deduced. The reactions studied were $^{56}Fe(n,n')^{56}Fe$, $^{56}Fe(n,p)^{56}Mn$, $^{56}Fe(n,2n)^{55}Fe$, $^{56}Fe(n,d + n,np)^{55}Mn$, $^{56}Fe(n,t + n,nd + n,2np)^{54}Mn$, $^{56}Fe(n,\alpha)^{53}Cr$, $^{56}Fe(n,n\alpha)^{52}Cr$, and $^{56}Fe(n,3n)^{54}Fe$. Values obtained for production cross sections as functions of incident neutron energy are presented in tabular form. 38 refs., 7 figs., 12 tabs.

52179 Reinvestigation of ^{56}Ni decay. Sur, B. (Nuclear Science Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (USA)); Norman, E.B.; Lesko, K.T.; Browne, E.; Larimer, R. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): 573-580 (Aug 1990). DOE Contract AC03-76SF00098.

In a series of experiments, we have reinvestigated the decay of the doubly magic nucleus ^{56}Ni, which is believed to be copiously produced in supernovae. We have confirmed its previously known decay scheme and half-life, and have searched for several rare decay modes. We establish an upper limit of 5.8×10^{-7} for the branching ratio of the second forbidden unique β^+ decay to the 158-keV level in ^{56}Co, leading to a lower limit of 2.9×10^4 yr for the half-life of fully ionized ^{56}Ni nuclei in cosmic rays. We also establish an upper limit of 5.0×10^{-3} for the branching ratio of the isospin forbidden Fermi electron capture transition to the 1451-keV level in ^{56}Co, which in turn leads to an upper limit of 124 keV for the isospin mixing Coulomb matrix element of the ^{56}Ni ground state.

52180 Proton mean field in ^{40}Ca between −60 MeV and +200 MeV deduced from a dispersive optical-model analysis. Tornow, W. (Department of Physics, Duke University, Durham, North Carolina 27706 (USA)); Chen, Z.P.; Delaroche, J.P. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): 693-706 (Aug 1990). DOE Contract AC05-76ER01067.

The p-^{40}Ca mean field is derived from an optical-model (OM) analysis that explicitly incorporates the dispersion relation connecting the real and imaginary parts of the mean field. This analysis is based on differential cross-section, analyzing power, and reaction cross-section data available in the energy range between 20 and 180 MeV. The extrapolation of the OM potential from positive to negative energies provides the shell-model potential. This extrapolation is guided by known single-particle energies. The deeply bound 1p and 1s orbits clearly indicate the need for a linear rather than an exponential energy dependence of the Hartree-Fock potential at large negative energies. The analysis also provides

root-mean-square radii, occupation probabilities, spectral functions, and absolute spectroscopic factors for proton single-particle orbits in ^{40}Ca. Our calculated 15% depletion of the hole states in ^{40}Ca is lower than that suggested for ^{208}Pb from theoretical and experimental studies. We also find that a substantial amount of single-particle strength in ^{40}Ca is located at rather high excitation energy.

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

52181 (INP–1414/PS, pp. 269-272) **Charged particle emission from the hot nuclei with high spin.** Fornal, B.; Fabris, D.; Hagel, K.; Natowitz, J.B.; Nebbia, G.; Prete, G.; Trotti, F.; Viesti, G. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Charged particle (p,α,d) emission from the deexcitation of the ^{59}Cu compound nuclei produced in the fusion of ^{32}S projectiles with ^{27}Al at projectile energies of 100 to 150 MeV in steps is studied. Measured spectra are compared with the results of standard statistical model calculations. 8 refs., 2 figs., 1 tab. (M.F.W.).

52182 (INP–1414/PS, pp. 293-299) **Internal bremsstrahlung from ^{59}Ni.** Jarzynski, C. (Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej); Janas, Z.; Kozlowska-Janek, B.; Pfuetzner, M.; Plochocki, A.; Rykaczewski, K.; Hornshoej, P.; Nielsen, H.L. Aarhus-Warsaw Collaboration. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The results of a series of experiments on internal bremsstrahlung in ^{59}Ni which consisted of single measurements of the spectrum of photon energies, corrected for background, detector resolution, efficiency and Compton scattering are presented. 6 refs., 2 figs. (author).

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 51585, 52192, 52209

52183 (INP–1414/PS, pp. 31-52) **Nuclei at the highest spins.** Deleplanque, M.A. (Lawrence Berkeley Lab., CA (USA)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

New regions of superdeformation have been found and some information about the ^{178}Os,^{104,105}Pd and ^{148}Gd nuclei is presented. The preliminary results of lifetime measurements in ^{135}Nd are given and the example of ^{178}Os is used to show the importance of such measurements. The structure and properties such as population, depopulation, magicity of superdeformed nuclei are examined. 33 refs., 18 figs. (M.F.W.).

52184 (INP–1414/PS, pp. 145-161) **The giant dipole resonance built on highly excited states.** Hesselink, W.H.A. (Vrije Univ., Amsterdam (Netherlands). Natuurkundig Lab.). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The results of two experiments, in which the properties of the GDR have been investigated in different domains of excitation energy and angular momentum, are presented. In a ^{110}Cd(α,γ) ^{114}Sn experiment the GDR decay has been separated from the background of statistical γ-rays following particle emission. In the second experiment the statistical decay of the GDR has been used to study the evolution of the nuclear shape with increasing angular momentum in $^{151-156}$Dy. 22 refs., 12 figs., 1 tab. (author).

52185 (INP–1414/PS, pp. 185-190) **Collisions between heavy nuclei near the barrier.** Henning, W. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Detailed information has recently become available on the reaction behaviour in very heavy nuclear systems close to the Coulomb barrier. Starting from an experimental study of the distribution of the reaction strength above and below the barrier, the dominant reaction channels of quasi-elastic and strongly-damped processes are examined. With decreasing incident energy, the sub-barrier collisions are increasingly dominated by quasi-elastic processes. From the division of internal excitation energy, new information is obtained on the nature of the dissipative processes. 15 refs., 4 figs. (author).

52186 (INP–1414/PS, pp. 285-287) **Gamow-Teller beta decay of even-even nuclides near ^{100}Sn.** Barden, R. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Gabelmann, H.; Grant, I.S. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The recent results of decay studies of the proton-rich nuclides ^{104}Sn and ^{98,100}Cd are presented. The experimental GT-strength is compared with theoretical predictions. 15 refs., 3 figs., 1 tab. (M.F.W.).

52187 (INP–1414/PS, pp. 201-214) **High energy photons: a probe for reaction dynamics in heavy ion collisions.** Metag, V. (Giessen Univ. (Germany, F.R.). 2. Physikalisches Inst.). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The emission of high energy photons in heavy ion collisions in the Fermi-energy domain is discussed. The experimental data are interpreted in terms of possible production mechanisms such as statistical emission from highly excited fragments or nucleon-nucleon bremsstrahlung. Future perspectives of hard photon emission and neutral meson production in heavy ion collisions at relativistic bombarding energies are outlined. 27 refs., 7 figs. (author).

52188 (INP–1414/PS, pp. 303-305) **Low-lying levels in ^{104}In and a possibility of observing spin-mixing.** Szerypo, J. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Barden, R.; Kirchner, R.; Klepper, O.; Roeckl, E.; Schardt, D.; Plochocki, A.; Rykaczewski, K.; Zylicz, J. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p.

Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The possibility of observing spin-mixing of the two low-lying levels in ^{104}In is studied. 8 refs., 2 figs. (M.F.W.).

52189 (KFK–4725) **Emission of light and intermediate mass fragments (IMF) in reactions of 156 MeV ^{6}Li-ions with ^{nat}Ag.** Wentz, J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik. May 1990. 79p. (In German). Order Number DE91706309. Source: NTIS (US Sales Only), PC A05/MF A01.

Double differential cross sections $d^2\sigma/(d\Omega x dE)$ for production of light charged particles ($Z \leq 2$) are measured in the reaction 156 MeV ^{6}Li + ^{nat}Ag at laboratory angles between 13.5deg and 25deg. Typical bell-shaped distributions around beam-velocity are obtained as a signature of direct fast processes. By using different theoretical assumptions (Serber, Glauber and DWBA) angle integrated (total) cross sections are obtained for measured light ejectiles. Together with existing data on intermediate mass fragments (IMF) emission in the above reaction, the data on light ejectiles are used in a sum-rule model analysis. The extented sum-rule model is studied in detail and a new normalization procedure is proposed which restores the basic ideas of the original sum-rule model (convergency in l-space and l-windows for different ejectiles). Accordingly, the model gives a good description of the experimental data on a wide range of ejectile charge numbers. (orig.).

52190 Evidence for the contribution of $0f_{5/2},1p_{3/2}$ proton excitations in the low-lying states in ^{92,94}Zr. Mach, H. (The Studsvik Neutron Research Laboratory, S-61182 Nykoeping (Sweden)); Warburton, E.K.; Krips, W.; Gill, R.L.; Moszynski, M. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): 568-572 (Aug 1990). DOE Contract AC02-76CH00016.

Lifetimes of $T_{1/2}$=88(3) and 291(11) ps were measured for the 0_2^+ states and $T_{1/2}$=102(3) and 500(13) ps for the 4_1^+ states in ^{92,94}Zr, respectively, using a recently developed β-γ-γ fast timing method. The observed $B(E2)$ values and the recently measured g factors for the 2_1^+ states in ^{92,94}Zr deviate strongly from properties of a pure $\nu 1d_{5/2}$ multiplet and even from the $\pi(1p_{1/2},0g_{9/2})\nu(1d_{5/2},2s_{1/2})$ shell-model results of Gloeckner. The experimental results are reproduced, however, by spherical shell model calculations with a model space of $\pi(0f_{5/2},1p_{3/2},1p_{1/2},0g_{9/2})\nu$ $(1d_{5/2},2s_{1/2},1d_{3/2},0g_{7/2})$ and provide compelling evidence for important contributions of $\pi f_{5/2},p_{3/2}$ orbits to the low-energy structure of these nuclei.

52191 Energy dependence of cross section for charge pickup of relativistic heavy ions. Guiru, J. (Physics Department, University of California, Berkeley, California 94720 (USA)); Williams, W.T.; Price, P.B. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): 769-770 (Aug 1990).

We have measured the cross sections for charge pickup (ΔZ=+1) reactions of ^{139}La nuclei at three energies in the interval 390–560 MeV/nucleon in a stack of VG-13 glass detectors ($\langle A \rangle$=26). Our results support evidence by Binnes *et al.* that the cross sections for charge pickup by heavy nuclei increase as the energy decreases below ~600 MeV/nucleon.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

Refer also to citation(s) 51585, 52183, 52187

52192 (INP–1414/PS, pp. 15-30) **Superdeformation - some recent Liverpool experiments.** Forsyth, P.D. (Liverpool Univ. (UK). Oliver Lodge Lab.). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Studies of superdeformed nuclear states in the mass-150 region carried out by the Liverpool group at the Nuclear Structure Facility at Daresbury are described. The measurements were made using the multi-detector TESSA γ-ray spectrometers. The earlier results on the nucleus ^{152}Dy are summarised and recent measurements in both ^{152}Dy and ^{150}Gd are discussed. 15 refs., 10 figs. (author).

52193 (INP–1414/PS, pp. 115-131) **Structure of transitional Dy nuclei along and above the yrast line.** Daly, P.J. (Purdue Univ., Lafayette, IN (USA)); Quader, M.A.; Piiparinen, M. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

States in ^{154}Dy have been located up to I^{π} - 48^{+} and their lifetimes measured. Marked structural changes occur along the yrast line with a transition from prolate to oblate shape, followed by an unexpected return to moderate collectivity at the highest spins. The quasicontinuum spectrum in the sequence of isotopes ^{152}Dy, ^{154}Dy and ^{156}Dy has also been studied. A pronounced E2 component is displayed in all three nuclei, but only ^{154}Dy shows a splitting of the E2 bump into two distinct parts, both of fast collective nature. The E2 statistical components could be reproduced in simple γ cascade calculations. 14 refs., 6 figs., 2 tabs. (author).

52194 (INP–1414/PS, pp. 263-267) **A search for γ-rays depopulating the ^{152}Dy SD-band.** Styczen, J.; Gueven, H.; Urban, W.; Hebbinghaus, H.; Gast, W.; Menegazzo, R.; Kleinheinz, P. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The ^{152}Dy nucleus was studied through the (α, 4n) reaction, using the 6-detector anti-Compton OSIRIS system. A number of earlier unplaced ^{152}Dy γ-rays was noticed. Selected pertinent coincidence spectra are shown. 5 refs., 2 figs., 1 tab. (author).

52195 (LAFI–149) **Study of ^{187}W excited states from the (n,γ) reaction.** Simonova, L.I.; Bejtin'sh, M.R.; Rezvaya, G.L.; Prokof'ev, P.T. AN Latvijskoj SSR, Riga (USSR). Inst. Fiziki. 1989. 29p. Order Number DE91603198. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

γ-ray spectra of ^{187}W from the (n,γ) reaction are studied in the 100-5500 keV energy range. In the energy interval of 1.5-2.5 MeV the γ-transition have been observed for the first time. The level scheme of ^{187}W with 93 levels has been deduced up to the 3.5 MeV excitation energy. The levels are determined using the energy combination principle, the intensity balance of the populated and de-excited γ-transitions and γ-γ coincidences. Some of the intermediate levels determined by the coincidence method are suggested to be doublets. 3 refs.; 3 tabs.

52196 Effects of nuclear deformation on ^{151,153}Eu(p,n)^{151,153}Gd reactions. Lanier, R.G. (Nuclear Chemistry Division, Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); West, H.I. Jr.; Mustafa, M.G.; Frehaut, J.; Adam, A.; Philis, C.A. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): R479-R482 (Aug 1990). DOE Contract W-7405-ENG-48.

Total cross sections for the ^{151,153}Eu(p,n)^{151,153}Gd reactions have been measured between 5 and 12 MeV. We observe a significant (≤35%) enhancement of the cross sections for ^{153}Eu relative to ^{151}Eu and find that the enhancement below ~10 MeV is due largely to the shape difference between ^{151}Eu(β_2=0.13) and ^{153}Eu(β_2=0.28).

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

Refer also to citation(s) 52185

52197 (INP–1414/PS, pp. 87-113) **Gamma spectroscopy of ^{208}Pb, ^{210}Po and ^{211}Bi with triton induced reactions.** Maier, K.H. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186– : 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Results of measurements of nuclear structure of ^{208}Pb, ^{210}Po and ^{211}Bi from triton induced reactions with a ^{209}Bi target are presented. 10 refs., 17 figs., 3 tabs. (M.F.W.).

52198 (INP–1414/PS, pp. 173-177) **Coulomb excitation of ^{226}Ra with ^{208}Pb.** Wollersheim, H.J. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Emling, H.; Grein, H. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The electromagnetic properties of ^{226}Ra have been investigated by multiple Coulomb excitation. Level energies and reduced transition probabilities of high-spin states have been determined. The results are discussed in terms of a stable octupole deformation. 12 refs., 3 figs., 1 tab. (author).

52199 (INP–1414/PS, pp. 281-283) **Search for the 33/2$^+$ state of the $\nu i_{13/2}^{-3}$ configuration in ^{199,201,203}Pb.** Fant, B. (Helsinki Univ. (Finland). Dept. of Physics); Weckstroem, T.; Rosengard, U.; Carle, P.; Kaellberg, A.; Norlin, L.O.; Rensfelt, K.G.; Jain, H.C. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The main purpose of this work is to search for the $\nu(i_{13/2}^{-3})_{33/2^+}$ state in ^{199,201,203}Pb. Results of the half-life and g-factor measurements are given. (M.F.W.).

52200 **Coulomb versus nuclear breakup in ^{11}Li fragmentation.** Bertsch, G. (Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824 (USA)); Esbensen, H.; Sustich, A. *Physical Review, C (Nuclear Physics) (USA),* 42(2): 758-761 (Aug 1990). DOE Contract W-31109-ENG-38.

The cross section for two-neutron removal from a beam of relativistic ^{11}Li is calculated in an eikonal approximation. We find a larger nuclear cross section in reactions with heavy nuclei than estimated by Kobayashi *et al.* This lowers the inferred Coulomb cross section for reactions on ^{208}Pb from 890 to a range of 560–740 mb, depending on the assumed single-particle binding energy of the valence neutron.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

52201 (INP–1414/PS, pp. 179-184) **Bimodal fission.** Sobiczewski, A. (Institute of Nuclear Research, Warsaw (Poland)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The nuclei around heavy fermion isotopes show some peculiarities in their spontaneous-fission properties such as the mass and the total kinetic energy distributions of the fission fragments, the multiplicity distribution of neutrons emitted from the fragments and the spontaneous-fission half-lives T_{sf}. A short review of these properties with the emphasis to bimodal fission which consists in the simultaneous appearance of two different modes of fission for a given nucleus: one mode corresponding to a low (about 200 MeV) and the other to a high (around 240 MeV) kinetic energy of the fission fragments, is given. 9 refs., 10 figs. (M.F.W.).

52202 (INP–1414/PS, pp. 233-260) **Optical spectroscopy of fission isomers - an experimental challenge.** Backe, H. (Mainz Univ. (Germany, F.R.). Inst. fuer Physik); Achenbach, W.; Arndt, Th. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Optical spectroscopy on americium fission isomers is discussed and it is explained why the fission - RADOP (radiation detected optical pumping) method is chosen. The main components of the experimental set-up are described: the ^{242}Pu target, the fission isomer accelerator and the optical cell. The experiments done to determine the neutralization rates of americium ions in argon and explain what happens if alkali vapour is added are also described. The results of the searches for a fission fragment anisotropy signal are presented. 36 refs., 15 figs. (author).

52203 (LA-UR–90-3193) **Parity and time-reversal symmetry nonconservation in neutron-nucleus interactions.** Bowman, J.D. (Los Alamos National Lab., NM (USA)); Bowman, C.D.; Knudson, J.; Penttilae, S.; Seestrom, S.J.; Szymanski, J.J.; Yuan, V.W.; Bush, J.E.; Frankle, C.M.; Gould, C.R.; Haase, D.G.; Mitchell, G.E; Delheij, P.P.J.; Postma, H.; Roberson, N.R. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36 ;AC05-76ER01067 ;FG05-88ER40441. (CONF-9005233–5: 2. international conference on medium- and high-energy physics, Taipei (Taiwan), 8-18 May 1990). Order Number DE91000425. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Parity non-conversation was studied for seventeen states in the compound nucleus ^{239}U by measuring the helicity dependence of the p-wave resonance cross section for epithermal neutrons scattered from ^{238}U. The root-mean-squared parity-violating matrix element for the mixing of p-wave and s-wave states was determined to be $M = 0.58_{-0.25}^{+0.50}$ meV. This corresponds to a parity-violating spreading width of $\Gamma^{PV} = 1.0 \times 10^{-7}$ eV. This gives a value of 4×10^{-7} for α_p, the ratio of strengths of the P-odd and P-even effective nucleon-nucleon interactions in ^{239}U. The implications of these results for studies of Time Reversal Symmetry in the compound nucleus is discussed.

6530 Nuclear Theory

Refer also to citation(s) 51974, 51983, 52107, 52127, 52165, 52189, 52201

52204 (BNL–45195) **Mesonic effects in nuclei near ^{208}Pb deduced from β decay.** Warburton, E.K. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-901057–2: 7. international symposium on capture gamma-ray spectroscopy and related topics, Pacific Grove, CA (USA), 14-19 Oct 1990). Order Number DE91000904. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The mesonic enhancement of the time-like component of the weak axial current in nuclear matter is very large and is best observed via its effect on the decay rate of $\Delta J = 0$ $(\pi_i\pi_f = -)$ β decay. Studies in the A = 16, 40, and 90 regions yield enhancements of 40–60% over the impulse approximation. The lead region is a rich source of information on these first-forbidden decays. This study is the first to extract information on mesonic enhancement from these decays. ^{206}Hg $\rightarrow$ ^{206}Tl $\rightarrow$ ^{206}Pb is chosen to exemplify the approach which has been applied to 10 or so first-forbidden decays in A = 205–214 nuclei. The nuclear wave functions are

evaluated via large-basis shell-model calculations. The results indicate a much larger enhancement than expected and thus the possibility of some non-nucleonic effect in addition to the mesonic enhancement considered to date.

52205 (DOE/ER/40150–129) **Schematic model of nuclear spin excitations.** Boucher, P.M. Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility. [1990]. 9p. Sponsored by Natural Sciences and Engineering Research Council of Canada; U.S. DOE Energy Research. DOE Contract AC05-84ER40150. (CEBAF-PR–90-005). Order Number DE91000432. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A simple model to estimate the strength of spin and nonspin collective states is presented. The model was inspired by early schematic models based on energy-weighted sum rules and is a useful tool for interpreting experimental data without the complexities of realistic microscopic calculations. The strength of collective states is calculated by assuming that a single collective state completely exhausts the energy-weighted sum rule. 19 refs.

52206 (GSI–90-39(prepr.)) **Strangeness production in ultra-relativistic heavy-ion collisions: Flavour kinetics. Pt. 2.** Barz, H.W. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)); Schulz, H.; Friman, B.L.; Knoll, J. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 23p. Order Number DE91706313. Source: NTIS (US Sales Only), PC A03/MF A01.

A recently presented model for the non-equilibrium expansion and hadronization of and the strangeness production in a quark-gluon plasma is developed further. The model includes all members of the lowest flavour SU(3) multiplets, the effect of particle evaporation from the surface of the system and a hydrodynamic treatment of the volume expansion. The evaporation and the decay of resonances are found to be equally important for the production of pions and kaons, and to give about 60% of the total yield. If a quark-gluon plasma is formed, the relative strangeness yield is strongly enhanced compared to pp collisions. The predictions of the model are also compared to recent data for nucleus-nucleus collisions. (orig.).

52207 (GSI–90-40(prepr.)) **Intermittency in nuclear multifragmentation.** Ploszajczak, M. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Tucholski, A. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jul 1990. 50p. Order Number DE91706315. Source: NTIS (US Sales Only), PC A03/MF A01.

Fluctuations of the fragment size distribution in a percolation model and in nuclear multifragmentation following the breakup of high energy nuclei in the nuclear emulsion are studied using the method of scaled factorial moments. An intermittent patern of fluctuations is found in the data as well as in the percolation lattice calculation. This is a consequence of both a self-similarity in the fragment size distribution and a random character for the scaling law. These fluctuations are in general well-described by percolation model. The multifractal dimensions are calculated and their relevance to the study of possible critical behaviour is pointed out. (orig.).

52208 (INP–1414/PS) **Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.** Broda, R.; Stachura, Z. (eds.). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. 338p. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The proceedings contain 16 lectures and 16 papers presented during seminars. Main topics of lectures and papers are nuclear structure, nuclear deformation excited and high spin states and heavy ion reactions. (M.F.W.).

52209 (INP–1414/PS, pp. 1-14) **Damping of rotational motion in nuclei.** Stephens, F.S. (Lawrence Berkeley Lab., CA (USA)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The lecture consists of three main parts. First, it is considered what rotational damping is and why it is interesting. In the second part the evidence for such damping is discussed and finally motional narrowing is mentioned (one aspect of the damping not understandable at all). 11 refs., 13 figs. (author).

52210 (INP–1414/PS, pp. 277-279) **Polarized electric dipole moment and octupole deformation of the nucleus.** Denisov, V.Yu. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Yadernykh Issledovanij). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The polarized electric dipole moment (PEDM) of the nucleus is calculated and the relationship between PEDM and octupole deformation is studied. 9 refs. (M.F.W.).

52211 (INP–1414/PS, pp. 289-292) **Subshell effects in the A≈100 region.** Mach, H. (Brookhaven National Lab., Upton, NY (USA)). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Subshell effects in the A≈100 nuclei are studied. (M.F.W.).

52212 (INP–1414/PS, pp. 273-275) **Quadrupole and hexadecapole deformations of ^{222}Ra in "cranking" and GCM models.** Robledo, L.M. (Universidad Autonoma de Madrid (Spain). Dept. de Fisica Teorica); Egido, J.L.; Nerlo-Pomorska, B.; Pomorski, K. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The results of the theoretical calculations of multipole deformations for ^{222}Ra in different approaches: mean field, cranking and GCM are presented and compared with the available experimental data. The collective hamiltonian is found within framework of the cranking and GCM method. (M.F.W.).

52213 (INP–1414/PS, pp. 321-325) **The role of n-p interaction in developing the nuclear deformation.** Dobaczewski, J. (Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej); Werner, T.; Nazarewicz, W.; Skalski, J. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The analysis of n-p interaction effects on the nuclear deformation within the self-consistent Hartree-Fock method with realistic effective two-body interaction is presented. 7 refs., 7 figs. (author).

52214 (INP–1414/PS, pp. 327-329) **The pairing interactions strength for the case of particle number projection.** Pilat, S. (Uniwersytet Marii Curie-Sklodowskiej, Lublin (Poland). Inst. Fizyki); Staszczak, A. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane,*

Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure. 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The pairing interactions strength is determined in the case of the number projection. Calculations are made for the rare-earth region. 6 refs., 2 figs. (M.F.W.).

52215 (INP–1414/PS, pp. 331-335) **Quasiparticle-core coupling calculations for odd N=83 nuclei.** Rashkova, N. (Sofia Univ. (Bulgaria)); Karloukovski, V.; Matev, M.; Michailova, M.M. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The purpose of the present paper is to analise the positive parity states of ^{137}Xe, ^{139}Ba, ^{141}Ce, ^{143}Nd and ^{145}Sm nuclei in the framework of the model in which it is supposed that the states of the odd A nucleus are superposition of the states R,A±1 of both (A-1) and (A+1) even-even nuclei. 11 refs., 2 figs. (author).

52216 (INP–1414/PS, pp. 313-319) **Classical calculations of the subbarrier fusion.** Blocki, J. (Institute for Nuclear Studies, Otwock-Swierk (Poland)); Skalski, J.; Sobiczewski, A. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The idea and some results of the classical calculations of the subbarrier heavy ion fusion reactions are presented. 5 refs., 4 figs. (M.F.W.).

52217 (INP–1414/PS, pp. 309-311) **Fission barrier in local approximation.** Strutinsky, V.M. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Yadernykh Issledovanij); Tsekmistrenko, I.Yu. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1988. (CONF-8804186–: 23. Zakopane school on physics, Zakopane (Poland), 16-30 Apr 1988). In *Proceedings of 23. Zakopane school on physics, Zakopane, Poland, 16-30 April 1988. Part 1: Part 1. Selected topics in nuclear structure.* 338p. Order Number DE91603094. Source: NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

The purpose of this paper is to calculate the dependence of nuclear deformation energy on the distance between centers of fission fragments. (author).

52218 (INS–835) **Quantum chaoticity and fractional parentage plot based on the microscopic theory of nuclear collective dynamics: Violation of separability condition to specify optimum collective subspace.** Tsukuma, H.; Sakata, F.; Marumori, T.; Yamamoto, Y. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Aug 1990. 85p. Order Number DE91713085. Source: NTIS (US Sales Only), PC A05/MF A01.

Being based on the dynamical theory of nuclear collective dynamics, in the previous paper, we have proposed a general method for evaluating the stochasticity of individual eigenfunctions. It has been demonstrated that an onset of quantum chaos is induced by a dissolution of quantum numbers, which is accompanied by the violation of separability condition for an optimum collective subspace. On the other hand, there exists a well established method for analyzing the stochasticity of an ensemble of eigenstates, i.e. the level statistics based on the random matrix theory which is based on some probabilistic assumptions. It is the objective of the present paper to build a bridge between the two different approaches to the quantum chaos, with and without probabilistic assumptions. (author).

52219 (KFTI–88-40) **Inclusive deuteron electrodisintegration outside the quasielastic peak and dibaryon resonances.** Rekalo, M.P.; Gakh, G.I.; Rekalo, A.P. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 23p. (In Russian). Order Number DE91603120. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Effect of dibaryon resonances (DR) on inclusive electron spectra in splitting of nonpolarized deuterons d(e,e')np is considered. Energy dependence of separate DR contributions is described by Breit-Wigner formula, masses and resonance widths with τ^P=0$^+$,1$^-$ and 2$^+$ are taken from results of multipole analysis in γ+d → n+p. Spin structure of resonance contributions describes absorption of virtual photons of low possible multipolarity, namely M1 under DR excitation with τ^P=0$^+$ and 2$^+$ and E1 - under DR excitation with τ^P=1$^-$; (n+p) system is formed at this singlet state. Resonance constants are found using χ^2-fitting of the model predictions based on account of DR and relativistic impulse approximation to experimental data relatively electron spectra in d(e,e')np in the vicinity of quasielastic peak. 102 refs.; 8 figs.

52220 (KFTI–88-42) **Low-energy pion interaction with lightest nuclei.** Gur'ev, V.N. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 16p. (In Russian). Order Number DE91603121. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The present state of low-energy pion interaction with ^{2}H, ^{3}He, ^{4}He nuclei is considered. Calculation of differential cross sections $(\alpha\sigma/d\Omega)_{\pi\pm}$ of elastic scattering of positive and negative pions on ^{4}He nucleus with the energy of T_π=30 MeV (in lab.syst.) and variation of inelasticity parameters with angular moment l=0 and 1 are presented. Highcriticality of estimations of total cross section for (π, ^{4}He) reaction extracted from elastic scattering analysis to $(d\sigma/d\Omega)_{\pi\pm}$ behaviour in minimum range is detected. Some actual problems of experimental and theoretial studies of low-energy pion interaction with the lightest nuclei are discussed. 25 refs.; 10 figs.; 1 tab.

52221 (KFTI–88-43) **Stochastic dynamics of quadrupole oscillations for krypton isotopes.** Bolotin, Yu.L.; Gonchar, V.Yu.; Tarasov, V.N.; Chekanov, N.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 12p. (In Russian). Order Number DE91603103. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Structure of classical phase space of Hamiltonian of quadrupole surface oscillations for krypton isotopes is studied. For each isotope a set of critical energies of transition from regular motion to chaotic one is determined. In the vicinity of local minima additional (excluding energy) motion integrals are constructed. 20 refs.; 6 figs.

52222 (LA-UR–90-3335) **General quadrupole shapes in the Interacting Boson Model.** Leviatan, A. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9009135–2: International conference on high spin physics and gamma-soft nuclei, Pittsburgh, PA (USA), 17-21 Sep 1990). Order Number DE91000178. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Characteristic attributes of nuclear quadrupole shapes are investigated within the algebraic framework of the Interacting Boson Model. For each shape the Hamiltonian is resolved into intrinsic and collective parts, normal modes are identified and intrinsic states are constructed and used to estimate transition matrix elements. Special emphasis is paid to new features (e.g. rigid triaxiality and coexisting deformed shapes) that emerge in the presence of the three-body interactions. 27 refs.

52223 (LBL–29482) **Order, chaos and nuclear dynamics: An introduction.** Swiatecki, W.J. Lawrence Berkeley Lab., CA (USA). Aug 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900857–1: Mikolajki summer school on nuclear physics: nuclear and atomic physics with accelerators of the nineties, Mikolajki (Poland), 26 Aug - 5 sep 1990). Order Number DE91000232. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This is an introductory lecture illustrating by simple examples the anticipated effect on collective nuclear dynamics of a transition from order to chaos in the motions of nucleons inside an idealized nucleus. The destruction of order is paralleled by a transition from a rubber-like to a honey-like behaviour of the independent-particle nuclear model. 10 refs., 6 figs.

52224 (SLAC-PUB-5343) **Anti-proton annihilation in nuclei as a probe of QCD.** Brodsky, S.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Sep 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900766-3: 1. biennial conference on low energy antiproton physics, Stockholm (Sweden), 2-6 Jul 1990). Order Number DE91000462. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Anti-proton annihilation in a nuclear target can test many novel aspects of quantum chromodynamics. In this talk I discuss a number of interesting features of such processes, including the formation of nuclear-bound quarkonium, tests of color transparency in hard, quasi-elastic nuclear reactions, higher-twist, coherent, and formation zone effects in hard inclusive nuclear reactions, reduced amplitude predictions for exclusive nuclear amplitudes, and color filter effects inclusive open and hidden charm production in nuclei. 43 refs., 6 figs., 2 tabs.

52225 (UCRL-JC-104986) **Needs for experiment and theory in intermediate energy reactions.** Blann, M. Lawrence Livermore National Lab., CA (USA). 5 Sep 1990. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9010199-1: Advisory group meeting on intermediate energy nuclear data for applications, Vinna (Austria), 9-12 Oct 1990). Order Number DE91000254. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We summarize several reasons intermediate energy data are needed in both basic and applied science. The status of the data base at energies up to 2 GeV is cursorily reviewed. Experimental excitation functions, single and double differential cross sections are compared with predictions of the nuclear model code ALICE. The strengths and weakness of the code to reproduce data are summarized. Opinions are given as to areas where data are too few or totally lacking, yet are needed for the verification of models and theories. 25 refs.

52226 **Calculational capabilities for nuclear data.** Bozoian, M. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM (US)). pp. 27-38 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186-: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

The Applied Nuclear Science Group of Los Alamos National Laboratory has provided theoretical expertise and nuclear data, particularly in the areas of neutron physics, fission and fusion, for many years. In this paper, the author outlines current efforts - low to intermediate energy nuclear models and calculations, resonance theory, activation analysis - that are pertinent and useful to materials scientists.

52227 **Finding nuclear data: The National Nuclear Data Center.** Pearlstein, S. (Brookhaven National Lab., Upton, NY (US)). pp. 189-196 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186-: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

Nuclear reaction cross-sections and nuclear structure properties are useful for material analysis applications. The nuclear data requirements for material analysis overlap with the data requirements for other research fields, e.g. fission and fusion reactors, so that reference material may be used more widely than the original purpose in mind. The National Nuclear Data Center at Brookhaven National Laboratory, an outgrowth of data compilation and evaluation activities begun more than 40 years ago, specializes in indexing the bibliography, data compilation and data evaluation of nuclear reaction cross- sections and nuclear structure properties. Reference material that are available in many forms that include handbooks, data bases and on-line services are reviewed.

52228 **Reply to "Comment on 'Monopole strength and shape coexistence in the $A \gtrsim 100$ mass region' ".** Mach, H. (Brookhaven National Laboratory, Upton, NY (USA)); Moszynski, M.; Gill, R.L.; Molnar, G.; Wohn, F.K.; Winger, J.A.; Hill, J.C. *Physical Review, C (Nuclear Physics) (USA)*, 42(2): 793-795 (Aug 1990).

We reply to the preceding comment.

6540 Radiation and Shielding Physics

Refer also to citation(s) 50653, 51447, 51701, 52238, 52433, 52501, 52585

52229 (CONF-8804141-, pp. 153-162) **Calculated Bethe stopping powers for protons in metals.** Sabin, J.R. (Univ. of Florida, Gainesville (USA)); Oddershede, J. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The previous calculations of atomic stopping powers and shell corrections have shown that a necessary condition for the calculation of Bethe stopping over the whole range of nonrelativistic electron stopping is that the stopping be considered shellwise, and that the mean excitation energy be considered as composed of contributions from individual shells. Comparison of calculated atomic stopping with experimental stopping powers leads to the conclusion that phase dependence of the total mean excitation energy is not as important as variation in the valence orbital mean excitation energy. This arises from the fact that the target phase dependent differences in stopping are prevalent at low energies, where stopping by the valence electrons is predominant. Recently a methodology has become available enabling the authors to make solid state calculations which are consistent with their atomic calculations. They thus report here comparison calculations for the phase dependence of the Bethe stopping of several metals for protons in the energy range 50 keV $< E_p <$ 40 MeV. 46 refs., 4 figs.

52230 (JAERI-M-90-092) **Experimental results of angular neutron flux spectra leaking from slabs of fusion reactor candidate materials, (1).** Oyama, Yukio (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Maekawa, Hiroshi; Yamaguchi, Seiya. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 128p. Order Number DE91712985. Source: NTIS (US Sales Only), PC A07/MF A01.

This report summarizes experimental data of angular neutron flux spectra measured on the slab assemblies of fusion reactor candidate materials using the neutron time-of-flight (TOF) method. These experiments have been performed for graphite (carbon), beryllium and lithium-oxide. The obtained data are very suitable for the benchmark tests to check the nuclear data and calculational code systems. For use of that purpose, the experimental conditions, definitions of key terms and results obtained are compiled in figures and numerical tables. (author).

52231 (JAERI-M-90-097) **Production of multi-group double differential form cross section library using JENDL-3 and benchmark test of fusion neutronics problems.** Nakagawa, Masayuki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Mori, Takamasa; Kaneko, Kunio. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 98p. (In Japanese). Order Number DE91713052. Source: NTIS (US Sales Only), PC A05/MF A01.

A 125 group double differential form cross section library has been produced from an evaluated nuclear data file JENDL-3. Benchmark problems on fusion neutronics were solved and the results were compared with measurements and calculated values by JENDL-3/PR1. The cross section set of twenty nuclides which are used in fusion neutronics analyses have been produced by the PROF-DD code system. Some multi-group activation cross sections have been also produced for reaction rate calculations. Four kinds of benchmark problems were solved in order to evaluate characteristics of JENDL-3. Those include the neutron leakage spectra from spherical piles measured in LLNL, the neutron multiplication experiments for beryllium sphere performed in Krchatov Laboratory, the JAERI-US calculational benchmark problems and the fusion blanket engineering experiment at the FNS. JENDL-3 gives similar tritium production rates in a blanket as JENDL-3/PR1. (author).

52232 (KURRI-TR-332) **Proceedings of 'workshop on physico-mathematical study useful for effective utilization of thermal neutrons in reactor'.** Shibuya, Iwao; Ueno, Yowri; Ueno, Sueo (eds.). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1990. 86p. (In Japanese). (CONF-9001118-: Workshop on physico-mathematical study useful for effective utilization of thermal neutrons in reactor, Kumatori (Japan), 8-9 Jan 1990). Order Number DE91712932. Source: NTIS (US Sales Only), PC A05/MF A01.

During the 'Workshop on Physico-Mathematical Study useful for Effective Utilization of Thermal Neutrons in Reactor', which took place in the Research Reactor Institute, Kyoto University, 8-9 January, 1990, fourteen scientific papers were presented to thirty participants. All of the papers are collected in this monograph of proceedings. In the present stage of the physical research utilizing neutron beams, new ideas and diversed conception are radically required. Then, it seemed that the application of the theory at radiative transfer in geo- and astro-physics, and the quantum statistical analysis in canonical ensembles would be most appropriate. The subject of this workshop consists of an introduction of the new approach to and theoretical ideas for the field of neutron utilization as follows: (a) The diagnosis of cancer by X-rays, gamma rays, and neutron beams; (b) The analytical and numerical computation of the multiple scattering models of the visible and radiant rays in plane-parallel, cylindrical and spherical media; (c) The computational analysis of the tomographic and geotopographic images; (d) The diffuse reflection of solar rays by terrestrial atmosphere, allowing for the ecological, anisotropic and topographic effects; (e) The inverse problems of radiant and visible rays in slab, cylindrical and spherical media; (f) The numerical solution of integro-differential equation, the neuronetwork models and artificial intelligence. (J.P.N.).

52233 (LA-UR-90-3127) **The effect of surface roughness on the phase of neutrons specularly reflected at grazing incidence.** Hamilton, W.A.; Pynn, R. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9008161-1: Workshop on methods of analysis and interpretation of neutron reflectivity data, Argonne, IL (USA), 23-25 Aug 1990). Order Number DE91000238. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The effect of surface roughness on the specular intensity of a reflected neutron beam can be calculated using the distorted wave Born approximation. For Gaussian roughness the result obtained is the familiar expression of Nevot and Croce. When the distribution of surface heights, z, is proportional to $\cosh^{-2}(z/2d)$, the calculated reflectance is $\sinh[\pi d(k_0-k_1)]/\sinh[\pi d(k_0+k_1)]$. Here k_0 and k_1 are the components of neutron wavevectors perpendicular to the interface, evaluated outside and inside the reflecting medium, and d is a measure of the amplitude of the roughness. This result for the reflectance differs by a phase factor from that obtained in an exact calculation for an interface with the corresponding graded refractive index. The phase difference between the two expressions is small, scaling as $\sim d^3$, and usually has little effect on measured reflectivities of multilayered structures. Ways in which the phase could be determined are discussed.

52234 (LUNFD6-NFRA-1024-1-63-1990) **Development and evaluation of attenuation and scatter correction techniques for SPECT using the Monte Carlo method.** Ljungberg, M. Lund Univ. (Sweden). Dept. of Radiation Physics. May 1990. 63p. (LUMEDW-MERI-1024-1-63-1990). Order Number DE91603090. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Quantitative scintigrafic images, obtained by NaI(Tl) scintillation cameras, are limited by photon attenuation and contribution from scattered photons. A Monte Carlo program was developed in order to evaluate these effects. Simple source-phantom geometries and more complex nonhomogeneous cases can be simulated. Comparisons with experimental data for both homogeneous and nonhomogeneous regions and with published results have shown good agreement. The usefulness for simulation of parameters in scintillation camera systems, stationary as well as in SPECT systems, has also been demonstrated. An attenuation correction method based on density maps and build-up functions has been developed. The maps were obtained from a transmission measurement using an external ^{57}Co flood source and the build-up was simulated by the Monte Carlo code. Two scatter correction methods, the dual-window method and the convolution-subtraction method, have been compared using the Monte Carlo method. The aim was to compare the estimated scatter with the true scatter in the photo-peak window. It was concluded that accurate depth-dependent scatter functions are essential for a proper scatter correction. A new scatter and attenuation correction method has been developed based on scatter line-spread functions (SLSF) obtained for different depths and lateral positions in the phantom. An emission image is used to determine the source location in order to estimate the scatter in the photo-peak window. Simulation studies of a clinically realistic source in different positions in cylindrical water phantoms were made for three photon energies. The SLSF-correction method was also evaluated by simulation studies for 1. a myocardial source, 2. uniform source in the lungs and 3. a tumour located in the lungs in a realistic, nonhomogeneous computer phantom. The results showed that quantitative images could be obtained in nonhomogeneous regions. (67 refs.).

6550 Medical Physics

Refer also to citation(s) 51298, 51827

52235 (KURRI-TR-329) **The records of radiation control division, no.25(1988).** Ishida, M.R. (and others); Kikuchi, Tadatoshi; Tsujimoto, Tadashi. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Mar 1990. 51p. (In Japanese). Order Number DE91712931. Source: NTIS (US Sales Only), PC A04/MF A01.

In this report, a general review of the daily activities and managements of The Division of Radiation Control, Research Reactor Institute, Kyoto University, in 1988, is described, and it is published as 'The Radiation Control Report: No. 25'. As the special matters, two big troubles of the reactor (KUR) arose; one was a leakage of the secondly cooling water from the heat exchangers, and the other was leakage of heavy water containing tritium from the heavy water thermal column for the neutron irradiation facility. For the repairs of these troubles, staffs of the Division of Radiation Control made their great efforts including radioactivity measurements of the leaked waters and air bones, and also radiation dose of the workers for the repairs of these facilities. These activities continued for more than one year. At present time, the repairing works are proceeding favorably and will complete within a few month. From the academic year from April of 1989, the new rules for the handlings of the radiation and radioactive substances will be enforced. Accordingly, in this year, 1988, the staffs of The Division of Radiation Control are making great efforts for the pretreatments to such situation. (author).

52236 (NORD-1990-32) **Natural radiation, nuclear wastes and chemical pollutants.** Christensen, T.; Ehdwall, H.; Stranden, E. (eds.). Nordisk Kontaktorgan for Atomenergispoergsmaal, Risoe (Denmark). Apr 1990. 63p. Project NKA RAS 430. Order Number DE91604387. Source: NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Doses from natural radiation to the population in Nordic Countries are summarized and man made modifications of the natural radiation environment are discussed. An account is given of the radiological consequences of energy conservation by reduced ventilation. Risks from possible future releases of radioactivity from final repositories of spent nuclear fuel are compared to the risks from present natural radioactivity in the environment. The possibilities for comparison between chemical and radiological risks are discussed.

52237 (RERF-TR-19-89) **Organ doses to atomic bomb survivors from radiological examinations at the Radiation Effects Research Foundation.** Kato, Kazuo; Antoku, Shigetoshi; Sawada, Shozo; Russell, W.J. Radiation Effects Research Foundation, Hiroshima (Japan). Apr 1990. 14p. Order Number DE91712968. Source: NTIS (US Sales Only), PC A03/MF A01.

When estimating the risks of oncogenesis and cancer mortality as a result of atomic bomb radiation exposure, medical X-ray doses received by the A-bomb survivors must also be estimated

and considered. Using a phantom human, we estimated the X-ray doses received by A-bomb survivors during routine biennial medical examinations conducted at RERF as part of the long-term Adult Health Study (AHS), since these examinations may represent about 45 % of the survivors' total medical irradiations. Doses to the salivary glands, thyroid gland, lung, breast, stomach and colon were measured using thermoluminescent dosimeters. The results reported here will aid in estimating organ doses received by individual AHS participants. (author).

52238 **Radiation hazards of (α,n) reactions.** Basu, S.N. (Los Alamos National Lab., Los Alamos, NM (US)); Tesmer, J.; Nastasi, M. pp. 279-286 of High energy and heavy ion beams in materials analysis. Tesmer, J.R.; Maggiore, C.J.; Nastasi, M.; Barbour, J.C.; Mayer, J.W. Materials Research Society, Pittsburgh, PA (USA) (1990). pp. 290 (CONF-8906186–: Materials Research Society high energy and heavy ion beams in materials analysis workshop, Albuquerque, NM (USA), 14-16 Jun 1989).

This paper deals with the radiation hazards associated with the generation of neutrons during (α,n) reactions. The neutron radiation dosage associated with the irradiation of the lower atomic number elements and some compounds are tabulated for incident α particles having energies up to 10 MeV. The tables also list the number of hours of radiation per week required to exceed a tenth of the maximum allowable radiation exposure of 5 rem per year.

6560 Condensed Matter Physics

Refer also to citation(s) 50649, 50725, 51205, 51206, 51223, 51243, 51265, 51347, 51453, 51461, 51470, 51952, 51966, 51972, 51983, 52226, 52227, 52309, 52341, 52588

52239 (AD-A–223427/6/XAB) **Monte Carlo study of the transient expansion of photogenerated plasmas in bulk semiconductors: Nonequilibrium phonon effects.** Joshi, R.P.; Tsen, K.T.; Ferry, D.K. Arizona State Univ., Tempe, AZ (USA). Center for Solid State Electronics Research. 15 May 1990. 9p. Contract N00014-90-J-1247. (N–90-7). Source: NTIS, PC A02/MF A01.

Pub. in Physical Review B, Vol. 41, No. 14, 9899-9906(15 May 1990).

The transient expansion of the photogenerated electron-hole plasma in semiconductors is examined with the ensemble Monte Carlo technique. A high photoexcitation energy is used to study the nonequilibrium optical-phonon effects, with both their temporal and spatial dependences being included for the first time. Specific numerical calculations within the picosecond regime are given for InP. Our results demonstrate that the nonequilibrium phonons significantly enhance the expansion of the plasma during the first few picoseconds, and change the spatial-carrier-distribution profiles.

52240 (CONF-900936–9) **Dose rate effects on damage formation in ion-implanted gallium arsenide.** Haynes, T.E.; Holland, O.W. Oak Ridge National Lab., TN (USA). Sep 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 7. international conference on ion beam modification of materials; Knoxville, TN (USA); 9-14 Sep 1990. Order Number DE91000394. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The residual damage in GaAs was measured by ion channeling following implantation of either 100 keV $^{30}Si^{+}$ at temperatures of 300K or 77K, or 360 keV $^{120}Sn^{+}$ at 300K. For room-temperature Si implants and fluences between 1 and 10 x 10^{14} Si/cm^2, the amount of damage created was strongly dependent upon the ion current density, which was varied between 0.05 and 12 μA/cm^2. Two different stages of damage growth were identified by an abrupt increase in the damage growth rate as a function of fluence, and the threshold fluence for the onset of the second stage was found to be dependent on the dose rate. The dose rate effect on damage was substantially weaker for $^{120}Sn^{+}$ implants and was negligible for Si implants at 77K. The damage was found to be most sensitive to the average current density, demonstrating that the defects which are the precursors to the residual dose-rate dependent damage have active lifetimes of at least 3 x 10^{-4} s. The dose rate effect and its variation with ion mass and temperature are discussed in the context of homogeneous nucleation and growth of damage during ion irradiation.

52241 (CONF-901116–8) **High-resolution heavy-ion-induced x-ray satellite emission study of implanted sulfur as a probe of co-implanted oxygen in an oxide substrate.** Rosseel, T.M. (Oak Ridge National Lab., TN (USA)); Young, J.P.; Vane, C.R.; Zuhr, R.A.; Peterson, R.S. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 11. international conference on the application of accelerators in research and industry; Denton, TX (USA); 5-8 Nov 1990. Order Number DE91000622. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Using high-resolution measurements, the relative fluorescence yields of the sulfur $K_\alpha L^n$ x-ray satellite lines produced by 24 MeV Si^{9+} ion irradiation of a series of quartz glass targets co-implanted to equal doses and depths of sulfur and oxygen have been obtained and compared to the yields from a series of quartz glass targets implanted to the same depth with sulfur only. The data exhibit lower yields in the higher-order KL^n satellite lines for the co-implanted oxygen targets but similar dose dependent curves. These results are consistent with oxygen increasing the valence electron density of the local sulfur environment. It also suggests that, with an appropriate choice of a probe ion, HIXSE may be capable of detecting impurity ions in matrices that normally mask the impurity, e.g., oxygen in oxide substrates. 10 refs., 3 figs.

52242 (CONF-8804141–, pp. 1-11) **Energy loss of a charged particle moving near the surface of a superlattice.** Gumbs, G. (Institut fuer Festkoerperforschung der Kernforschungsanlage Julich (West Germany)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

In this paper, the surface response function $g(q_{\|},\omega)$ is calculated for an array of parallel two-dimensional electron gas layers ($q_{\|}$ is the wave vector parallel to the surface and ω is the frequency). Here, a point charge moves along a prescribed path above the surface. The external potential generated by this charged particle will give rise to an induced potential which outside the superlattice can be written as a sum of evanescent plane waves whose amplitude defines the linear response function g. It is implicitly assumed that the external potential is so weak that the medium couples linearly to it. Of course, the function $g(q_{\|},\omega)$ is related to the density-density response function. The energy transfer Δ E from the particle probe is obtained by integrating the Poynting vector over the surface and over time. A general expression for Δ E for an arbitrary particle trajectory is obtained in terms of the loss function Im $g(q_{\|},\omega)$ which is proportional to the power absorption in the medium due to the external electric potential. Explicit closed form results for g are presented for a multi-layered system. Numerical results for the energy loss have been obtained for a single layer. 17 refs., 2 figs.

52243 (CONF-8804141–, pp. 13-18) **Image states on insulators.** Arnau, A. (Universidad del Pais Vasco, Euskadi (Spain)); Echenique, P.M. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Image states represent a very simple and fundamental class of surface states which might be very useful to study the two dimensional (2-D) electron gas. Intensive work has been done directed to understand the properties of such states in different surfaces. In materials with a small dielectric constant, like helium, the binding is weak (≈meV) and an unstability of the 2-D electron gas develops when the density is increased. In metals the binding is stronger (≈0.7eV), but a problem arises because the energy halfwidth of these states due to decaying into bulk states (interband) is too high and comparable to the one associated with the loss of parallel momentum within the band (intraband). In insulators, such as diamond or LiF, relatively strong binding appears and escape outside

the band into bulk states is prevented by the electronic structure. In these conditions it is possible to think in the possibility of filling a 2-D electron band. The remaining problem should be the experimental procedure to fill efficiently these states. In this work the authors have calculated the halfwidth of the first image state of an electron at a vacuum-LiF surface using a self energy formalism. 5 refs., 1 fig., 1 tab.

52244 (CONF-8804141–, pp. 19-26) **Potential barrier for tunneling electrons in STM [scanning tunneling microscope].** Pitarke, J.M. (Euskal Herriko Unibertsitatea, Bilbo (Spain)); Echenique, P.M. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The correct interpretation of vacuum-tunneling experiments achieved with the scanning tunneling microscope (STM) makes it necessary to know about the effective potential barrier that an electron leaving the surface sees. A variety of semiclassical and quantum-mechanical approaches are available to calculate the attractive potential between an external charged particle and a semi-infinite polarizable medium, but local effects are not negligible for the distances of interest, and a simple local formalism cannot be applied, either, so it is necessary to include, at the same time, local and non-local correlations effects. Consequently, the determination of this potential barrier is a difficult task and it remains an open problem. Recently some work has been performed going beyond the local density formalism (LDA). The tunneling current in a metal-vacuum-metal junction is very sensitive to the detailed form of the potential barrier between the electrodes, and specially sensitive are the positions of the transmission resonances which occur in the region close to the metal-vacuum interface where the momentum of the electron can be real, so the tunneling electrons can serve as a probe of this surface-interaction. Indeed, the STM has been used to study the distance-voltage characteristics (d-V_a) in the constant current mode, and tunneling resonances, that is, peaks in the dJ/dV_a curve have been observed in recent experiments, as predicted by Gundlach. Thus, in order to estimate the shape of the potential barrier that electrons feel when they tunnel the vacuum region, the author has carried out theoretical calculations of the dI/dV_a-V_a characteristics for a W(110) tip on a AU(110) sample. 14 refs., 2 figs.

52245 (CONF-8804141–, pp. 27-35) **Elastic and inelastic interaction in STEM [Scanning Transmission Microscope].** Zabala, N. (Universidad del Pais Vasco, San Sebastian (Spain)); Rivacoba, A.; Echenique, P.M. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The recent development of the Scanning Transmission Microscopy (STEM) has stimulated the interest in the interaction of high energy electron beams with small particles and surfaces. When the geometry of the target is simple enough, it is useful to describe the target, in the frame of the classical electrodynamics by means of a dielectric function $\epsilon(\omega)$. Electrons in the beam can be described as classical point particles, or by a quantum wave function. In the classical approach one studies the interaction of the electron with the field induced by itself in the target. 16 refs., 4 figs.

52246 (CONF-8804141–, pp. 37-47) **Excitonic interaction in GaAs/GaA*l*As quantum wells.** Sung, C.C. (Univ. of Alabama, Huntsville (USA)); Mo, G. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Calculation of excitonic states in GaAs/GaA*l*As quantum wells is applied to analyze the anti-crossing energy levels of observed data of 2s-light-hole and 1s-heavy-hole excitons. It is shown that the difference of the energy levels is determined by the excitonic interaction proportional to the population of the excitons. Various sets of parameters in the literature are used to compare with the data. 6 refs., 1 fig.

52247 (CONF-8804141–, pp. 49-58) **Recoil saturation of the self-energy in atomic systems.** Manson, J.R. (Clemson Univ., SC (USA)); Ritchie, R.H. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Within the framework of the general self-energy problem for the interaction of a projectile with a many-body system, the authors consider the dispersion force between two atoms or between a charge and an atom. Since the Born-Oppenheimer approximation is not made, this is a useful approach for exhibiting non-adiabatic effects. They find compact expressions in terms of matrix elements of operators in the atomic displacement which are not limited by multipole expansions. 7 refs.

52248 (CONF-8804141–, pp. 59-75) **Review of convoy electron phenomena.** Sellin, I.A. (Univ. of Tennessee, Knoxville (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

This brief review emphasizes sharp distinctions between convoy electron production phenomena observed for light ion projectiles ($Z_p \sim 1$, $v_p \sim 1$ au) traversing solid targets with those observed for heavy ion projectiles ($Z_p \gtrsim 10$, $v_p \gtrsim 10$ au). The relative importance of bulk and surface production phenomena for the two cases are discussed in the context of corresponding experimental data. Data concerning an enhanced transport length observed for convoy electrons accompanying the penetration of fast, heavy ions through solids are discussed, and used to set the stage for a corresponding theoretical discussion of the stochastic perturbation of Coulomb orbits in solids, the subject of a companion theoretical discussion by J. Burgdoerfer. 9 refs., 6 figs.

52249 (CONF-8804141–, pp. 77-85) **Transport theory for convoy electrons and Rydberg electrons in solids.** Burgdoerfer, J. (Univ. of Tennessee, Knoxville (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Recent experimental investigations of excitation of near-threshold states in fast ($v_p \gg 1$; v_p: projectile velocity) highly charged ($q \gg 1$, q: ionic charge) ions traversing thin solid targets have revealed several interesting and heretofore unexplained features. For convoy electrons, i.e. electrons in low-energy continuum states in the projectile frame just above threshold, anomalous transport properties as well as a high degree of anisotropy in the angular distribution have been reported. Convoy electrons give rise to a cusp shaped peak in the forward emission spectrum of electrons whose velocity vector $\vec{v}$ matches the projectile velocity, $\vec{v} = v_{\text{convoy}}$. For high Rydberg states just below threshold an abundant population of high ℓ states, absent in ion-atom collisions under otherwise identical conditions of projectile velocity and charge state, has been observed. A quantitative description of the evolution of the atomic charge cloud around fast highly charged ions in solids within the framework of classical transport theory is being developed. This amounts to the solution of a phase space master equation for the distribution function $f(\vec{r}, \vec{v})$ which takes properly into account competing effects of the strong Coulomb field, of screening, and of the stochastic perturbations in the solid due to multiple scattering. A numerical solution can be achieved by solving the associated Langevin equation for individual phase space trajectories and employing Monte Carlo sampling techniques. In

this progress report the author briefly outlines the theoretical framework and presents first results on the transport effects of Coulomb focussing, defocussing and trapping. 6 figs.

52250 (CONF-8804141–, pp. 87-90) **Electron emission from collective excitation of solids by heavy ion impact.** Rothard, H. (J. W. Goethe-Universitaet, Frankfurt (West Germany)); Burkhard, M.; Biedermann, C.; Heil, O.; Hofmann, D.; Kemmler, J.; Koschar, P.; Kroneberger, K.; Groeneveld, K.O. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Collective excitation of the electron plasma of a solid by a penetrating heavy ion can lead to the emission of low energy electrons. In double differential energy- and angular distributions of secondary electrons from sputter-cleaned solid surfaces from heavy ion impact structures are observed which can be related to 1. wake-induced shock electrons and 2. electrons resulting from the decay of plasmons. The emission of these electrons is strongly influenced by both surface contamination and structure. The directed emission of shock electrons offers the possibility to study the refraction of low energy electrons by the surface potential barrier. 14 refs., 4 figs.

52251 (CONF-8804141–, pp. 91-94) **ECC [electron-capture-to-continuum] cusp shapes for H^+ and H^{++} on atomic and molecular targets.** Bissinger, G. (East Carolina Univ., Greenville (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Recently the results have been published of measurements of zero-degree electron energy spectra with ~MeV/u bare H and He on C_mH_n gases [1] with m = 1, 2, 3, 4, 5 and 7 and observed an abrupt cusp shape change when $m \geq 4$. This cusp shape change, which appeared as a noticeable increase in the sharpness of the cusp peak, was extracted by the straightforward point-by-point subtraction of the scaled CH_4 cusp shape from the other molecular cusp shapes. This difference peak was called the W peak and had the properties that its skewness, FWHM, yield dependence on projectile Z and energy, FWHM dependence on Z_p, and peak position on analyzer angular position differed from both ECC and ELC cusp behaviors. However when the hydrocarbon molecule had $m < 4$, there was no significant cusp shape difference between these cusps and those obtained with atomic Ar targets [2]. This surprising result could not be explained either as an electron-capture-to-continuum (ECC) or electron-loss-to-continuum (ELC) process and hence the only remaining process for forward electron production, Brandt-Ritchie wake model for solids, was applied to the molecular hydrocarbon results with some success. Moreover, further measurements on fluorocarbons showed that the cusp shape, even for the smallest molecule, CF_4, showed evidence of the W peak. Coincidence measurements performed for 2.4 MeV He^{++} with the m = 1-5 hydrocarbon series looking for correlations between the He^+ exit charge state did not show any obvious change in coincidence yield for the m = 4 or 5 hydrocarbon targets. Covering a broad range of molecular targets to examine molecular parameters of possible importance such as size, valence electron density, shape, number of electrons, etc., no parameter appeared to correlate with the presence of the W peak except the number of electrons in the molecule. 5 refs., 4 figs.

52252 (CONF-8804141–, pp. 95-97) **Scanning tunneling microscopy and spectroscopy.** Warmack, R.J. (Oak Ridge National Laboratory, TN (USA)); Ferrell, T.L. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The technique of scanning tunneling microscopy is demonstrated to provide topological as well as spectroscopic information. The three parameters under experimental control are tunneling current (I), tunneling bias (V), and tip altitude (d). By holding one constant and measuring the dependence of the other two, interesting spectroscopic data may be obtained. Differential conductivity (dI/dV) measurements can be interpreted as surface density of states information. An inelastic channel should open at the surface plasmon energy of the material to which tunneling occurs, yielding a peak in dI/dV. Shown are the results of a calculation of the work involved in transporting an electron to a silver film on a silicon slab. The probability of exciting the plasmon for these materials reveals a simple peak very close to the surface plasmon energy for silver. A significant shifting and splitting of this peak would be expected for thin films of other materials where the bulk and surface modes are more widely separated.

52253 (CONF-8804141–, pp. 99) **New directions in scanning-tunneling microscopy.** Ferrell, T.L. (Oak Ridge National Laboratory, TN (USA)); Warmack, R.J.; Reddick, R.C. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The tunneling of electrons in scanning-tunneling microscopy (STM) has permitted imaging of the electronic distribution about individual atoms on surfaces. The need for use of conducting surfaces in STM limits its applicability, and new forms of scanning microscopy have emerged as a result of interest in poorly conducting samples. Atomic force microscopy has demonstrated that the force between a surface and a probe tip can be used to image selected materials. Now being developed are magnetic probe STM's and photon tunneling microscopes in which the probe is a sharpened optical fiber. Also of great interest presently is the measurement of differential conductance of surfaces using electron STM's. This method supplies spectral information and contrast enhancement in images. At present there remains much theoretical work to be carried out in order to better characterize related data on inelastic electron tunneling, and valuable insight may be gained from data being gathered on the local work function of materials. As matters stand today, the key problems lie in determining tip and contamination effects, preparation of samples, and understanding conductivity mechanisms in very thin materials on conducting substrates. Resolution of these problems and introduction of new forms of scanning microscopy may permit novel and important applications in biology as well as surface science.

52254 (CONF-8804141–, pp. 101-112) **Inner-shell excitation by channeled electrons.** Pennycook, S.J. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

An interesting situation occurs when inner shell electrons in crystalline materials are excited by electron beams of kilovolt energies in a transmission electron microscopy. For many years the subsequent x-ray emission has been used as the basis of an analytical technique, giving compositional information at high spatial resolution. Recently this technique has been extended to provide information on impurity lattice site location, the basis of the technique being to take two fluorescence spectra, one under channeling conditions and on random spectrum with the crystal oriented away from strongly channeling planes or axes. Since electrons channel along the positive potential wells of the atomic planes or strings, a higher yield of characteristic x-ray emission is expected from the channel case, for the same incident beam current. The channeling effect can be defined as the relative increase in x-ray yield. Consider for simplicity a nonatomic matrix A and an impurity X which has a substitutional fraction F_s and the remainder is randomly located. Only the fraction F_s of the impurity will show a channeling effect and a quantitative measure of substitutionality has been given. This analysis will only work if the individual inner shells under consideration are excited with equal efficiency under both channeling and random conditions. This is not true for the excitation of more weakly bound shells. For a typical beam energy of 100 keV incident on crystals along a major axis, the width of the

electron distribution about the atomic string is a small fraction of an angstrom. 4 refs., 2 figs.

52255 (CONF-8804141–, pp. 113-141) **Cherenkov x rays: Recent experimental results.** Moran, M.J. (Univ. of California, Livermore (USA)); Schneider, M.B.; Chang, B.; Maruyama, X.K. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Preliminary experimental results show the measurement of Cherenkov x rays for silicon and carbon foils. The measured distributions demonstrate grazing-angle enhancement of the emission flux, where relativistic electrons are incident on the foils at near-grazing angles. This behavior was predicted in a paper presented at the preceding Werner Brandt Workshop. 7 refs., 16 figs.

52256 (CONF-8804141–, pp. 123-141) **Radiative electron capture [REC].** Vane, C.R. (Oak Ridge National Laboratory, TN (USA)); Datz, S.; Dittner, P.; Giese, J.; Gomez del Campo, J.; Jones, N.; Krause, H.; Miller, P.D.; Schoere, H.; Schulz, M. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

This paper contains experimental data on ion channeling in solids. The x-ray spectrum for 160 MeV sulfur ions passing through a silicon target is given. Peaks are due to target and projectile K x-rays and from L- and L-radiative electron capture (REC) processes in which a target electron is transfered to the L- or K-shell, respectively, of a bare- or one-electron sulfur projectile ion moving in the solid and a photon is emitted which carries away the excess energy.Iso given is (1) the x-ray spectrum for 160 MeV bare sulfur ions axially channeled through silicon, (2) charge state distributions of sulfur ions exiting a silicon crystal in channeling and random orientations, (3) schematic representations of the REC process, (4) cross sections for radiative recombination and REC, (5) REC portions of x-ray spectra for bare sulfur ions channeled axially through a silicon crystal, (6) measured and calculated K-REC peak positions for bare- and one-electron sulfur ions channeled through silicon crystals, (7) measured and calculated widths of the K-REC peaks for bare sulfur ions channeled in silicon crystals, (8) K-REC peak centroid position results for 120 to 130 MeV sulfur 16+, (9) yield of K-REC x-rays from bare sulfur ions channeled through silicon crystals, (10) x-ray spectra generated by bare oxygen ions traversing a hydrogen gas, and (11) comparison between x-ray data and a computer generated simulation based on radiative electron capture from an atomic hydrogen target.

52257 (CONF-8804141–, pp. 143-152) **Optical, mass, and Auger spectra from e-bombarded KBr.** Arakawa, E.T. (Oak Ridge National Laboratory, TN (USA)); Kamada, M. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The authors have measured the mass spectrum and optical emission lines of neutral potassium atoms ejected from KBr at T = 300°K and 443°K bombarded by 2-keV electrons. The room-temperature data may be complicated by the non-stoichiometry of the alkali-enriched sample surface and seem difficult to interpret. The high-temperature sample, which maintains the proper stoichiometry, produces data in support of gas-phase excitation of alkali atoms desorbed from the surface. 15 refs., 4 figs.

52258 (CONF-8804141–, pp. 163-172) **Energy deposition by partially stripped ions.** Crawford, O.H. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The collisional deposition of energy by partially stripped ions, and by neutral atoms, is studied. A projectile with known charge is considered to interact with a target, and the expected excitation energy of the target is calculated in a nonrelativistic high-velocity limit, ignoring exchange. This treatment has its most natural application to the near-surface region of a target; i.e., within a mean free path for changes in the electronic state of the projectile. This work was motivated by interest in light emission from solids under irradiation. In the case of opaque targets, such as metals, any light observed must come from very close to the surface, in which case the treatment given here is applicable. 6 refs. 4 figs.

52259 (CONF-8804141–, pp. 173-180) **Enhanced electron-capture and charge variation of molecular ions.** Steuer, M.F. (Univ. of Georgia, Athens (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The following question is asked: For molecular ions moving within a stopping medium, its atomic-ion components separating under the influence of their mutual repulsion, how do the charges of the atomic ions vary with the dept of penetration? To address this question, the author considers a diatomic, homonuclear molecular ion whose center of mass moves with velocity V in a solid. He can describe this molecular ion as a pair of atomic ions having equal nuclear charges, Z, each carrying a number, N(x), of electrons which are bound to their respective centers of force. Let the displacement of nuclear charge Z1 relative to nuclear charge Z2 be described by the internuclear separation R. For a depth of penetration into the solid, x, the internuclear separation, R(x) = R(t), will be determined by the Coulomb explosion between the interacting charges, q1 = q2 = q(x), where q(x) = Z-N(x). The relative motion of the ion pair may be neglected so that each atomic ion moves with the velocity of the center of mass; i.e., V1 = V2 = V. For the present, he restricts consideration to molecular ions whose internuclear axes are aligned parallel with the direction of the beam. 4 refs., 1 fig.

52260 (CONF-8804141–, pp. 182-199) **Sputtering by fast ions using a sum of impulses.** Johnson, R.E. (Univ. of Virginia, Charlottesville (USA)); Sundqvist, B.U.R.; Hedin, A.; Fenyo, D. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

A simple, unifying description of the sputtering of solids by fast ions is given using a sum of impulses. For both electronic and collisional energy deposition the scaling of the yield vs. (dE/dx) is in qualitative agreement with experiment in three different regimes of (dE/dx) for which the nature of the ejection process changes: single events, diffusive spike, and pressure pulse. At very high (dE/dx) a volume ejection mechanism (linearized pressure pulse) is described in which the yield scales as $(dE/dx)^3$ when the ion penetration depth is large. This accounts for the dependence of the measured yield of intact, thermally-labile biomolecules ejected from the solid state, and roughly describes the measured ejection angles for the intact molecular ions. 30 refs., 1 fig.

52261 (CONF-8804141–, pp. 181) **Electronic sputtering.** Johnson, R.E. (Univ. of Virginia, Charlottesville (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

Electronic sputtering covers a range of phenomena from electron and photon stimulated desorption from multilayers to fast heavy ion-induced desorption (sputtering) of biomolecules. In this talk the author attempted. Therefore, to connect the detailed studies of argon ejection from solid argon by MeV ions and keV electrons to the sputtering of low temperatures molecular ices by MeV ions then to biomolecule ejection from organic solids. These are related

via changing $(dE/dx)_e$, molecular size, and transport processes occurring in materials. In this regard three distinct regions of $(dE/dx)_e$ have been identified. Since the talk this picture has been made explicit using a simple spike model for individual impulsive events in which spike interactions are combined linearly. Since that time also the molecular dynamics programs (at Virginia and Uppsala) have quantified both single atom and dimer processes in solid Ar and the momentum transport in large biomolecule sputtering. 5 refs.

52262 (CONF-8804141–, pp. 201-205) **Mechanism of H_n^+ and H^- desorption during fast ion bombardment.** da Silveira, E.F. (Texas A & M Univ., College Station (USA)); Schweikert, E.A. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

After emission of electrons and photons, hydrogen species are the next secondary particles to leave the surface of a solid exposed to bombardment of fast ions. Their desorption yield, energy distribution, and angular distribution should reflect the conditions existing near the heavy ion track at 10^{-13} to 10^{-11} seconds after the impact of the projectile. The measurement and analysis of those quantities should thus provide important and perhaps unique information about the mechanism of energy transfer from the projectile to the desorbed species. In this paper, the authors present the relative desorption yields of H^-, H^+, H_2^+, and H_3^+, measured for several surface conditions using ^{252}Cf-Particle Desorption Mass Spectrometry (PDMS). 8 refs., 3 figs.

52263 (CONF-8804141–, pp. 229-240) **A core plasma model of track structure in insulators.** Ritchie, R.H. (Oak Ridge National Laboratory, TN (USA)); Ashley, J.C.; Killough, G. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

How do tracks form on insulators following the passage of swift, densely ionizing particles? The authors use a core plasma model to study the tracks for chlorine ions in silicon dioxide. Particle tracks are narrow, stable chemically reactive centers of strain composed of displaced atoms rather than electronic defects. It is assumed that most of the energy deposited goes into electronic excitation and ionization rather than into nuclear motion. It is concluded that calculations of yields, track radii, etc. as a function of projectile energy need to be made.

52264 (CONF-8804141–, pp. 241-250) **Phase effects for electrons in liquid water and water vapor.** Turner, J.E. (Oak Ridge National Laboratory, TN (USA)); Wright, H.A.; Hamm, R.N.; Ritchie, R.H.; Paretzke, H.G. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The objective of these studies is to compare transport, energy loss, and other phenomena for electrons in water in the liquid and vapor phases. Understanding the differences and similarities is an interesting physics problem in its own right. It is also important for applying the relatively large body of experimental data available for the vapor to the liquid, which is of greater relevance in radiobiology. This paper presents a summary of results from a series of collaborative studies carried out by the authors at Oak Ridge National Laboratory (ORNL) and the Gesellschaft fur Strahlen- und Umweltforschung (GSF). In these studies, identical calculations were performed using two Monte Carlo computer codes: the ORNL code, OREC, for liquid water and the GSR code, MOCA, for water vapor. 4 refs., 14 figs.

52265 (CONF-8804141–, pp. 251-258) **Physical and chemical interactions in irradiated water containing DNA.** Wright, H.A. (Oak Ridge National Laboratory, TN (USA)); Hamm, R.N.; Turner, J.E.; Klots, C.E.; Bolch, W.E. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

When a charged particle interacts with liquid water it undergoes inelastic energy loss events that produce ionizations and excitations of water molecules. The electrons produced during ionization events may have enough energy themselves to produce further ionizations and excitation in slowing down to subexcitation energies. These physical interactions occur very rapidly – within 10^{-15}s in a local region of space – and result in the production of ionized water molecules (H_2O^+), excited water molecules (H_2O^*) and subexcitation electrons. During the prechemistry period to approximately 10^{-12}s chemically reactive ions and radicals are formed. Subsequently, these ions and radicals diffuse through the water and react chemically with each other or with other molecules that may be present in solution. The authors have developed a Monte Carlo computer code to simulate these physical and chemical processes in liquid water. The code transports a charged particle and all of its secondaries through liquid water and tabulates the position and identity of each physical interaction. It then calculates the position and identity of each chemically reactive ion or radical produced in the track. 10 figs.

52266 (CONF-8804141–, pp. 269-280) **An analytic representation of the radial distribution of dose from energetic heavy ions in water, SI, LIF, and NaI.** Katz, R. (Univ. of Nebraska, Lincoln (USA)); Loh, Kim Sum; Huang, Guo Rong. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

An earlier representation of the radial distribution of dose about the path of a heavy ion in liquid water is modified and extended to include silicon, lithium fluoride, and sodium iodide. 6 refs., 5 figs., 1 tab.

52267 (CONF-8804141–, pp. 281-296) **Calculated yields of ammonia in the radiolysis of deoxygenated solutions of glycylglycine.** Bolch, W.E. (Univ. of Florida, Gainesville (USA)); Turner, J.E.; Yoshida, H.; Jacobson, K.B. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

This paper presents detailed Monte Carlo simulations of physical and chemical interactions occurring within electron tracks in deoxygenated solutions of glycylglycine. Hydrated electrons produced within these tracks react with the solute to produce ammonia and a peptide secondary free radical. Calculated yields of ammonia are presented for a range of solute concentrations and electron energies. Excellent agreement is found between calculated and measured yields of ammonia in solutions irradiated by 250-kVp X-rays and ^{60}Co gamma rays. 12 refs., 5 figs.

52268 (CONF-8804141–, pp. 207-227) **On the calculation of wave-number vector- and frequency-dependent dielectric response function for cubic ice.** Zaider, M. (Columbia Univ., New York, NY (USA)); Fry, J.L.; Orr, D.E. Oak Ridge National Lab., TN (USA). Sep 1989. From 11. Werner Brandt workshop on charged particle penetration phenomena; Oak Ridge, TN (USA); 14-15 Apr 1988. In *The 11th Werner Brandt workshop on charged particle penetration phenomena.* 299p. Order Number DE90000959. Source: NTIS, PC A13/MF A01.

The authors give in this paper a description of the formalism, algorithms, and computer techniques necessary for performing a full-scale, ab-initio calculation of the frequency- and wave-number-dependent dielectric response function for water. A number of preliminary results are reported and interpreted vis-a-vis available data. The calculation is performed for cubic ice, basically in order to be able to take advantage of simplifications resulting from the invariance to translation of the system (Bloch's theorem). Two further simplifications resulted from using the random-phase approximation

and a semiphenomenological crystal Hamiltonian to obtain the band structure. 21 refs., 4 figs.

52269 (CONF-9006272–1) **Berry phases and Wyckoff positions for energy bands in solids.** Zak, J. (Technion-Israel Inst. of Tech., Haifa (Israel). Dept. of Physics). Argonne National Lab., IL (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 18. international colloquium on group theoretical methods in physics; Moscow (USSR); 4-9 Jun 1990. Order Number DE90017814. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report discusses work on Berry phases and wyckoff positions for energy bands in solids. Talk in this report was limited to simple bands. (JDL)

52270 (CONF-9009261–2) **The development of projectile excitation during ion-solid collisions observed through convoy electron emission.** Elston, S.B. (Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy). Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC05-84OR21400. From Workshop on fast ion collisions; Debrecen (Hungary); 17-19 Sep 1990. Order Number DE91000725. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Preliminary results and interpretation are presented for a recent experiment designed to explore the evolution of electronic excitation of a projectile ion during flight through a solid target by monitoring the development of high-order multipole moments of the convoy electron angular distribution as a function of target thickness.

52271 (CONF-9009261–3) **Electronic excitations in fast ion-solid collisions.** Burgdoerfer, J. (Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy). Oak Ridge National Lab., TN (USA). [1990]. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Workshop on fast ion collisions; Debrecen (Hungary); 17-19 Sep 1990. Order Number DE91000736. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We review recent developments in the study of electronic excitation of projectiles in fast ion-solid collisions. Our focus will be primarily on theory but experimental advances will also be discussed. Topics include the evidence for velocity-dependent thresholds for the existence of bound states, wake-field effects on excited states, the electronic excitation of channeled projectiles, transport phenomena, and the interaction of highly charged ions with surfaces. 44 refs., 14 figs.

52272 (DOE/ER/14090–1) **Pulse propagation in inhomogeneous optical fibers: Progress report, September 15, 1989–September 14, 1990.** Menyuk, C.R. Maryland Univ., Baltimore, MD (USA). Dept. of Electrical Engineering. 19 Sep 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER14090. Order Number DE91000821. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses research at the University of Maryland on optical fiber switches and the propagation of solutions through the optical fibers. (LSP)

52273 (DOE/ER/45131–8) **[The physics of pattern formation at liquid interfaces]: A survey of recent and current work.** Pittsburgh Univ., PA (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45131. Order Number DE91000856. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses pattern formation at liquid interfaces and interfaces within disordered materials. The particular topics discussed are: a racetrack for competing viscous fingers; an experimental realization of periodic boundary conditions; what sets the length scale for patterns between miscible liquids; the fractal dimension of radial Hele-Shaw patterns; detailed analyses of low-contrast Saffman-Taylor flows; and the wetting/absorption properties of polystyrene spheres in binary liquid mixtures. (LSP)

52274 (DOE/ER/45239–T2) **[Atomic and electronic structure of metals and alloys: Clean surfaces and chemisorbed molecules]: Progress summary.** State Univ. of New York, Stony Brook, NY (USA). Research Foundation. Sep 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER45239. Order Number DE91000267. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this second period of support we have concentrated exclusively on three subjects, namely, (1) rare earths, bulk and surfaces; (2) ultrathin films of strained metallic phases; and (3) improvement of experimental facilities. In the area of rare earths we have analyzed the photoemission data collected at beamline U7B of the National Synchrotron Light Source from a single-crystal platelet of Tb(0001).

52275 (DOE/ER/45376–2) **Dynamics of surface melting: Progress report, 1 January 1990–31 December 1990.** Elsayed-Ali, H.E. Rochester Univ., NY (USA). Lab. for Laser Energetics. Aug 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45376. Order Number DE91000978. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The objectives of this program is to study the phenomenon of surface melting of single crystals of metals, to test for its existence, and to investigate its dynamics. Both conventional static electron diffraction and dynamic ultrafast electron diffraction are used in our study. This year, the ultrahigh vacuum facility containing the picosecond electron reflection high-energy electron diffraction system was equipped with a cylindrical mirror analyzer and a static electron gun for Auger spectroscopy. An image analysis system capable of acquiring the pulsed diffraction patterns was assembled and used in analysis of picosecond laser heated surfaces. A large set of time-resolved experiments were conducted to study the thermal response of Pb(110) to picosecond laser heating. The surface Debye-Waller effect was used to time-resolve the evolution of surface temperature. This provided us with a picosecond time-resolved surface lattice temperature probe. Results for laser fluences below surface melting show agreement with a heat-diffusion model. The temperature dependence of the Pb(100) along the [110] and the [001] azimuths using x-ray photoelectron forward scattering of the $4f_{7/2}$ core-level photoelectrons confirmed, for the first time, surface melting of Pb(100) at temperatures as low as 560 K.

52276 (IC–90/95) **Scaling theory of quantum resistance distributions in disordered systems.** Jayannavar, A.M. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 14p. Order Number DE91602866. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have derived explicitly, the large scale distribution of quantum Ohmic resistance of a disordered one-dimensional conductor. We show that in the thermodynamic limit this distribution is characterized by two independent parameters for strong disorder, leading to a two-parameter scaling theory of localization. Only in the limit of weak disorder we recover single parameter scaling, consistent with existing theoretical treatments. (author). 32 refs, 4 figs.

52277 (IC–90/114) **Optical properties of metallic Fibonacci quasi-superlattice.** Feng Weiguo (International Centre for Theoretical Physics, Trieste (Italy)); Liu Nianhua; Wu Xiang. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 13p. Order Number DE91602821. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Within the approximation of hydrodynamic model, the optical properties of the metallic Fibonacci quasi-superlattice have been studied for the region of s-polarized soft x-rays and extreme ultraviolet. By using the transfer-matrix method and taking account of damping effects, we have discussed the electromagnetic normal modes for the quasisuperlattice in the rational approximation. The related dispersion curves explain the reflection spectra well, and we found that similar to the reflectivities, both real part and imagine part of the dispersion relation pattern has a rich structure of self-similarity. With the increasing of the generation number, the electromagnetic modes all become critical. (author). 13 refs, 3 figs.

52278 (IC–90/116) **Fixed scale transformation for Ising and Potts clusters.** Erzan, A. (International Centre for Theoretical Physics, Trieste (Italy)); Pietronero, L. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 22p. Order Number DE91602822. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The fractal dimension of Ising and Potts clusters are determined via the Fixed Scale Transformation approach, which exploits both the self-similarity and the dynamical invariance of these systems at criticality. The results are easily extended to droplets. A discussion of inter-relations between the present approach and renormalization group methods as well as Glauber-type dynamics is provided. (author). 20 refs, 7 figs, 2 tabs.

52279 (INP–1377/PL) **Proceedings of 22. Zakopane school on physics, Zakopane, Poland, 1-15 May 1987. Part 2: Part 2. Condensed matter studies by nuclear methods.** Krolas, K.; Tomala, K. (eds.). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1987. 320p. (CONF-8705201–: 22. Zakopane school of physics, Zakopane (Poland), 1-8 May 1987). Order Number DE91602823. Source: NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Separate abstracts were prepared for 4 of the papers in this volume. 1 paper was introduced into INIS system before and the remaining 9 papers were considered outside the subject scope of INIS. (M.F.W.).

52280 (INP–1377/PL, pp. 69-87) **Ion implantation of Te and I ions in Si and GaAs studied by Moessbauer spectroscopy, ion channeling and nuclear orientation.** Langouche, G. (Louvain Univ. (Belgium). Inst. for Nuclear- and Radiationphysics). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1987. (CONF-8705201–: 22. Zakopane school of physics, Zakopane (Poland), 1-8 May 1987). In *Proceedings of 22. Zakopane school on physics, Zakopane, Poland, 1-15 May 1987. Part 2: Part 2. Condensed matter studies by nuclear methods.* 320p. Order Number DE91602823. Source: NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

This paper deals mainly with results obtained with Moessbauer spectroscopy and ion channeling on the behaviour of Te and I atoms in semiconductors. The newest results deal with implantations in GaAs. 26 refs., 8 figs., 3 tabs. (author).

52281 (INP–1377/PL, pp. 88-121) **Iron implantation in garnets studied by CEMS, X-ray diffraction at glancing angles and transmission electron microscopy.** Marest, G. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1987. (CONF-8705201–: 22. Zakopane school of physics, Zakopane (Poland), 1-8 May 1987). In *Proceedings of 22. Zakopane school on physics, Zakopane, Poland, 1-15 May 1987. Part 2: Part 2. Condensed matter studies by nuclear methods.* 320p. Order Number DE91602823. Source: NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Due to their numerous physical properties, garnets are often used in new technologies. Recently it has been shown that high doses implanted ions, chemically reacting with the matrix could give interesting results. If the bulk is completely amorphized after implantation, further annealings can recrystalize it. In this study $Y_3F_5O_{12}$, $Y_3Al_5O_{12}$ and $Gd_3Ga_5O_{12}$ single crystals were 100 keV implanted with ^{57}Fe ions at doses ranging between 10^{16} and 10^{17} ions.cm^{-2}. The iron chemical states were determined thanks to Conversion Electron Moessbauer Spectroscopy (CEMS) and it was shown that the alloying elements of the matrix could influence the nature of the created phases. After thermal treatments the sample superficial layers were characterized using CEMS, glancing angle X-Ray Diffraction (GXRD), Transmission Electron Microscopy (TEM) and Rutherford Backscattering Spectroscopy (RBS). Different annealing stages were put forward: the oxidation of the implanted iron below 650 deg C and the garnet recrystallization around 850 deg C with some iron substitution in the garnet octahedral and tetrahedral sites. The overstoichiometric iron forms particles of mixed oxides $(FeAl)_2O_3$, $(FeGa)_2O_3$ or particles of pure Fe_2O_3 oxide depending on the garnet. For the first time it is proved that after annealing around 1200-1300 deg C a complete rebuilding of the garnet matrix can induce for these oxide particles at room temperature a Morin transition. 44 refs., 29 figs., 3 tabs. (author).

52282 (INP–1377/PL, pp. 137-146) **Recent results of PAC applied to study of magnetic alloys.** Rots, M. (Louvain Univ. (Belgium). Inst. for Nuclear- and Radiationphysics). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1987. (CONF-8705201–: 22. Zakopane school of physics, Zakopane (Poland), 1-8 May 1987). In *Proceedings of 22. Zakopane school on physics, Zakopane, Poland, 1-15 May 1987. Part 2: Part 2. Condensed matter studies by nuclear methods.* 320p. Order Number DE91602823. Source: NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

Two new applications of PAC in the study of magnetism will be introduced. The first topic is devoted to the problem of reentrance behaviour, the nature of which is still controversal especially in the case of AuFe alloys around 18 at%Fe. Recently the applicability of PAC to the study of spin-glass freezing was investigated and the results in the reentrant concentration region were discussed. Here I add new results on the interplay between local atomic order and the appearance of the double magnetic transition: paramagnetic-ferromagnetic-spin glass upon cooling. In the second part I introduce preliminary PAC results on the study of antiferromagnetism in manganese and its alloys. 8 refs., 4 figs. (author).

52283 (INP–1377/PL, pp. 147-155) **Recent developments in PAC surface studies.** Schatz, G. (Konstanz Univ. (Germany, F.R.). Fakultaet fuer Physik); Klas, T.; Platzer, R.; Voigt, J.; Wesche, R. Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1987. (CONF-8705201–: 22. Zakopane school of physics, Zakopane (Poland), 1-8 May 1987). In *Proceedings of 22. Zakopane school on physics, Zakopane, Poland, 1-15 May 1987. Part 2: Part 2. Condensed matter studies by nuclear methods.* 320p. Order Number DE91602823. Source: NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS.

The PAC surface investigations are performed by utilizing the radioactive ^{111}In probes deposited at the copper crystals surfaces. PAC time spectra are shown for the three main orientations of the copper system Cu(111), Cu(100) and Cu(110). 8 refs., 6 figs., 1 tab. (author).

52284 (INT–194/I, pp. 91-99) **Study of the admixtures distribution in solids by residual activity measurement.** Sowa, M. (Uniwersytet Marii Curie-Sklodowskiej, Lublin (Poland). Inst. Fizyki); Szyszko, W.; Sielanko, J. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. (In Polish). (CONF-8509466–: Polish symposium on development and application of isotopic methods in engineering and technology, Zakopane (Poland), 11-14 Sep 1985). In *Development and application of isotopic methods in engineering and technology: Proceedings of the Polish Symposium 11-14 September 1985 Zakopane.* 132p. Order Number DE91604461. Source: NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The distributions of As and P admixtures implanted in Si mono- and polycrystals are studied by means of radiochemical and ion etching methods. 12 refs., 5 figs., 1 tab. (M.F.W.).

52285 (KFTI–88-25) **Simulation of sputtering of multicomponent solids by ion bombardment: program system PERST.** Nikiforov, V.I.; Pavlenko, V.I.; Slabospitskij, R.P.; Khirnov, I.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 12p. (In Russian). Order Number DE91604880. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Basic version of problem-oriented program system PERST for simulation of sputtering of multicomponent solids by ions heavier than lithium in the kinetic energy range of 50 eV -500 keV at incidence angle of 0-90 deg C is developed. PERST system as a program product is described. Particular attention is paid to automation of programs formation for research work. 13 refs.; 1 fig.; 1 tab.

52286 (KFTI–88-44) **Parametric X radiation of low-energy electrons in monocrystals.** Adejshvili, D.I.; Blazhevich, S.V.; Bochek, G.L.; Lapko, V.P.; Morokhovskij, V.L.; Fursov, G.L.; Shchagin, A.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 4p. (In Russian). Order Number DE91602873. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Spectra of parametric X radiation (PR) of E=24 MeV electrons in silicon crystal (the crystal thickness is 240 nm) at an angle of Θ_k=298.4 mrad relatively to electron motion direction ($\Theta_k > mc^2/E$) are measured. The crystal is so oriented that crystallographic plane

(III) is perpendicular to radiation plane and is under Φ angle relatively to direction of relativistic electron motion. PR spectrum has a sharp intensity maximum at $\omega \simeq 13$ keV that is characterized by high monochromaticity. Energy in spectrum maximum is smoothly changed by varying the crystal orientation angle Φ. Dependence of PR maximum intensity energy on the crystal orientation angle Φ with variation of Φ angle near $\Theta_B/2$ is studied. This dependence shows that PR kinematics coincides with that of coherent bremsstrahlung. 9 refs.; 3 figs.

52287 (KFTI–88-45) **Dependence of displacement fields on the damage cluster nucleus geometry.** Grigor'ev, A.N.; Zabela, A.G.; Nikolajchuk, L.I.; Prokhorenko, E.M.; Khizhnyak, N.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 7p. (In Russian). Order Number DE91602874. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Displacement fields in doped crystals of cubic and hexagonal structures containing extended defects are studied. The numerical results are presented depending on the damage cluster nucleus geometry. All calculations are based on analytical representations of displacement fields in an integral form using elasticity theory equations. The investigation results are vital for radiation physics as they permit to predict and calculate both the character and geometry of distortions near damaged region cluster and determine cluster parameters on the basis of the known structure of distortions. Dependences are obtained for the following monocrystals: Mg, ZnO, CdS, W, Au. 6 refs.; 3 figs.

52288 (LAFI–151) **Space correlations at radiation-defect storage and aggregation in solids.** Pirogov, F.V. AN Latvijskoj SSR, Riga (USSR). Inst. Fiziki. 1989. 26p. (In Russian). Order Number DE91602875. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Qualitative effects of many-particle correlations for systems with reactions A+B→0 and A+B→A are considered. The influence of generation rate, diffusion coefficient, interaction radii upon the generation-recombination aggregation and sink distribution fluctuations upon the defect space distribution have been studied. A simple method which describes the effect of many-particle correlations in the case of large concentrations is presented. 32 refs.; 1 tab.

52289 (LA-UR–90-2975) **XUV free-electron laser-based projection lithography systems.** Newnam, B.E. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9007157–2: SPIE conference on EUV x-ray and gamma-ray instrumentation for astronomy, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE91000441. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Free-electron laser sources, driven by rf-linear accelerators, have the potential to operate in the extreme ultraviolet (XUV) spectral range with more than sufficient average power for high-volume projection lithography. For XUV wavelengths from 100 nm to 4 nm, such sources will enable the resolution limit of optical projection lithography to be extended from 0.25 μm to 0.05μm and with an adequate total depth of focus (1 to 2 μm). Recent developments of a photoinjector of very bright electron beams, high-precision magnetic undulators, and ring-resonator cavities raise our confidence that FEL operation below 100 nm is ready for prototype demonstration. We address the motivation for an XUV FEL source for commercial microcircuit production and its integration into a lithographic system, include reflecting reduction masks, reflecting XUV projection optics and alignment systems, and surface-imaging photoresists. 52 refs., 7 figs.

52290 (LA-UR–90-2976) **Photoabsorption modulation in GaAs: $Ga_{1-x}In_x$ as strained-layer superlattices.** Sella, I. (Los Alamos National Lab., NM (USA)); Watkins, D.E.; Laurich, B.K.; Smith, D.L.; Subbanna, S.; Kroemer, H. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-901105–14: Fall meeting of the Materials Research Society, Boston, MA (USA), 24 Nov - 1 dec 1990). Order Number DE91000440. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Photoabsorption modulation measurements have been made on $Ga_{1-x}In_xAs$ – GaAs strained-layer superlattices using two approaches: In the first the modulating beam and the test beam have the same wavelength (near the exciton resonance). In the second, the modulation wavelength is much shorter than the test beam wavelength. A dramatic difference is observed in the modulated transmission spectra near the excitonic level for the two modulating wavelengths. The difference in behavior can be explained by screening of the residual surface electric field, which only occurs for the high photon energy modulating beam. This beam excites carriers that are free to drift in the surface field before they are captured in the quantum wells. Carriers excited by the low photon energy modulation beam are created in the wells and can not effectively screen the surface field. We describe a model which explains the nonlinear intensity saturation profile and qualitatively describes the spectral line shape. 4 refs., 4 figs.

52291 (LA-UR–90-3129) **Angular dependence of thin-film dielectric coating damage thresholds.** Boyer, J.D.; Foltyn, S.R.; Mauro, B.R.; Sanders, V.E. Los Alamos National Lab., NM (USA). [1989]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-891163–4: 21. annual symposium on optical materials for high power lasers, Boulder, CO (USA), 1-3 Nov 1989). Order Number DE91000237. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Newman et al. reported experiments showing that the angular dependence of 351-nm laser damage thresholds in HfO_2/SiO_2 multilayer dielectric reflectors was much weaker than even the $1/\cos\theta$ expected from simple geometric fluence dilution. Several plausible explanations were suggested, but none were convincing. We propose a simple geometric model based on a cylindrical form for the coating defect responsible for damage initiation. We have measured 248-nm damage thresholds for bare fused silica, evaporated aluminium films, and HfO_2/SiO_2 and Al_2O_3/SiO_2 dielectric reflectors at angles out to 85°. The measured data agree well with our simple model.

52292 (LA-UR–90-3329) **A three-dimensional tight-binding model for trans-polyacetylene.** Wang, X. (Los Alamos National Lab., NM (USA)); Campbell, D.K.; Lin, H.Q.; Vogl, P. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9009257–2: International conference on science and technology of synthetic metals, Tuebingen (Germany, F.R.), 2-7 Sep 1990). Order Number DE91000182. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We develop a three-dimensional (3-D) generalization of the one-dimensional (1-D), tight-binding Su-Schrieffer-Heeger (SSH) model for trans-$(CH)_x$. Importantly, the model faithfully reflects the 3-D character of the band-edge states as found in ab initio Local-Density-Approximation (LDA) calculations but remains simple enough to be analytically solvable for the dimerized ground state. We examine the density of states and the optical absorption predicted within this model, paying special attention to the roles of the transverse coupling and the polarization of the probing field.

52293 (LBL–26455, pp. 55) **Optical second-harmonic generation as a surface probe for noncentrosymmetric media.** Stehlin, T.; Feller, M.; Guyot-Sionnest, P.; Shen, Y.R. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

In recent years, optical second-harmonic generation (SHG) has proved to be an effective and sensitive tool for studies of a large variety of surface and interface properties. It has yielded, for example, information about structural and electronic properties of metal and semiconductor surfaces. However, experiments so far have been restricted to substrates with inversion symmetry, since the SHG is forbidden in the bulk but allowed at the surface, giving this technique its unique surface specificity. The authors show in the present work that, with proper polarization combinations, this restriction to media with inversion symmetry can be relaxed. SHG can then be used as an effective surface probe with submonolayer sensitivity for all interfaces accessible by light. For demonstration, the authors have studied with SHG the adsorption of Sn on GaAs,

since semiconductor-metal interfaces are of great interest in fundamental as well as applied semiconductor research.

52294 (LBL–26455, pp. 61) **Multifractal structure of attractors at the quasiperiodic transition to chaos for electron-hole plasma instability in Ge.** Kim, Y. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The scaling structure of attractors at the transition from quasiperiodicity to chaos has been studied for an electron-hole plasma instability in Ge crystal. The scaling function f(a) spectrum calculated from the time series of the plasma current oscillation at the onset of chaos is in good agreement with that of a circle-map model. The experimental power spectrum also confirms that the transition to chaos is well described by the circle map. The extrinsic noise effect on the f(a) spectrum is discussed by using the circle map.

52295 (LBL–26455, pp. 76) **Incommensurable magnetic surface structures for MnO-type antiferormagnetic insulators.** Chrzan, D.C.; Falicov, L.M. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

A calculation of the magnetic (001) surface structure of an antiferromagnetic insulator with the MnO spin arrangement is reported. The calculation is based on classical spins with Heisenberg interactions that are (a) between second neighbors throughout the bulk and surface, (b) between nearest-neighbor spins at the surface layer, and (c) between nearest-neighbor spins in the first and second layers. It is found that, for a range of exchange parameters, incommensurable ground-state structures are obtained.

52296 (LBL–26455, pp. 77-78) **Work in progress.** Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

An exact solution of a four-site crystal model with periodic boundary conditions, a (001) thin film with face-centered-cubic crystal structure, is being developed for the nickel density of electron states, as would be measured in surface-sensitive valence-band photoemission. The object is to study modifications of the many-body electronic structure in the presence of surfaces. A realistic local-density-approximation one-electron structure and intrasite electron-electron interactions most generally allowed by atomic symmetry are used. The crystal-field effect in the nickel film will be examined. The photoemission spectrum will be calculated and compared with the bulk result. Physical conclusions for true nickel surface many-body states are expected to be obtained.

52297 (LBL–26455, pp. 59-60) **Work in progress.** Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Optical SHG is being used to study laser thermal desorption of molecules from metal surfaces. Combining the technique with conventional thermal desorption should allow an unambiguous determination of the preexponential factor and the desorption energy. Two interfering laser beams can create a monolayer grating of adsorbed molecules on a surface by laser desorption. This can be monitored by the multiorder diffraction of SHG from the surface. The technique is being used to probe the grating profile. As the molecules diffuse on the surface and the grating smears out, the diffraction signal decays away. The results lead to a determination of the surface-diffusion constant of the molecules. Anisotropy in surface diffusion can also be probed.

52298 (SAND–90-1772C) **Far-infared laser spectroscopy of two dimensional holes in strained-layer heterostructure and superlattices.** Lin, S.Y. (Princeton Univ., NJ (USA). Dept. of Electrical Engineering); Tsui, D.C.; Klem, J.F.; Jones, E.D.; Dawson, L.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Grant 88-0248. (CONF-901105–15: Fall meeting of the Materials Research Society, Boston, MA (USA), 24 Nov - 1 dec 1990). Order Number DE91000027. Source: NTIS, PC A01/MF A01 - OSTI; GPO Dep.

We report far-infrared magneto-transmission data at 4.2 K on a series of p-type strained layer $Al_xGa_{1-x}As/In_yGa_{1-y}As/GaAs$ quantum well (QW) structure and $InAs_{0.15}Sb_{0.85}/InSb$ superlattices (SLS). The $Al_xGa_{1-x}As/In_yGa_{1-y}As/GaAs$ QW structure consists of strained $In_yGa_{1-y}As$ layers of 100 Å in thickness and a space layer having thickness (W_{sp}) ranging from 30 Å to 700 Å. The $InAs_{0.85}/InSb$ SLS was grown on top of a 1.0μm $InAs_{0.15}Sb_{0.95}$ strain relief buffer layer consisting of alternating layers of 100 Å $InAs_{0.15}Sb_{0.85}$ and 200 Å InSb. The detail of the sample structures has been described elsewhere. The two-dimensional (2D) hole density (p_{2D}) of the sample is obtained from the period of the Shubnikov-de Hass oscillations in quantum transport measurements made at 4.2 K. The magneto-transimission experiments are performed in magnetic field (B) up to 8.5 T using polarized radiation and the spectrum is displayed as 4 $Log_{10}[T(B)/T(0)]$, where T(B) is the transmittance at B.

52299 (UCRL–101766) **A high temperature, plasma-assisted chemical vapor deposition system.** Brusasco, R.M. (Lawrence Livermore National Lab., CA (USA)); Britten, J.A.; Thorsness, C.B.; Scrivener, M.S.; Unites, W.G.; Campbell, J.H.; Johnson, W.L. Lawrence Livermore National Lab., CA (USA). Feb 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8911192–7: 1989 Boulder damage symposium, Boulder, CO (USA), 1-3 Nov 1989). Order Number DE91000260. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have designed and built a high-temperature, plasma-assisted, chemical vapor deposition system to deposit multilayer optical coatings of SiO_2 and doped-SiO_2 flat substrates. The coater concept and design is an outgrowth of our recent work with Schott Glasswerke demonstrating the use of plasma assisted CVD to prepare very high damage threshold optical coatings. The coater is designed to deposit up to several thousand alternating quarterwave layers of SiO_2 and doped SiO_2 substrate at deposition rates up to several microns per minute. The substrate is resistively heated to about 1000°C during the deposition phase of the process. The plasma is driven by a 13.56 MHz RF unit capable of producing power densities of up to 140 W cm^{-3} in the reaction zone. The coater is designed to be adaptable to microwave generated plasmas, as well as RF. Reactant gas flow rates of up to 10 slm can be achieved at a 10 tar operating pressure. Reactants consist of O_2, $SiCl_4$ and a volatile halogenated dopant. These gases react in the plasma volume producing SiO_2 with dopant concentrations of up to a few percent. A variable dopant concentration is used to produce index differences between adjacent optical layers.

52300 **Partial least-squares calibration diagnostics applied to the FT-IR analysis of borophosphosilicate glass (BPSG) thin films.** Haaland, D.M. (Sandia National Lab., Albuquerque, NM (US)). pp. 425-426 of Proceedings of the 7th international conference on Fourier transform spectroscopy: Volume 1145. Cameron, D.G. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 642 DOE Contract AC04-76DP00789. (CONF-890674–: 7. international conference on Fourier transform spectroscopy, Fairfax, VA (USA), 19-23 Jun 1989).

Full-spectrum multivariate calibration methods are capable of providing a multitude of diagnostic capabilities for evaluating the quality of the calibration, identifying problem calibration samples, and flagging unknown samples whose analysis by these methods might be unreliable. These diagnostics are demonstrated for the analysis of BPSG thin films on silicon using infrared spectroscopy and partial least-squares methods.

52301 **Spectral densities of the symmetric Anderson model.** Silver, R.N. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM (USA)); Gubernatis, J.E.; Sivia, D.S.; Jarrell, M. *Physical Review Letters (USA),* 65(4): 496-499 (23 Jul 1990).

The spectral density of the single-impurity Anderson model is calculated by a combination of quantum Monte Carlo method to provide data on the Matsubara Green's function, the maximum-entropy method of image reconstruction to invert numerically the

spectral representation, and perturbation theory to provide informative default models. The Kondo central peak of the spectral density is shown to be a universal function of ω/T_K and T/T_K at low frequencies, where T_K is the Kondo temperature. The higher-frequency side peaks are nonuniversal. With decreasing T/T_K the Kondo peak grows as the screened local moment disappears.

52302 **Modeling electron-electron interactions in reduced-dimensional materials: Bond-charge Coulomb repulsion and dimerization in Peierls-Hubbard models.** Campbell, D.K. (Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, NM (USA)); Gammel, J.T.; Loh, E.Y. Jr. *Physical Review, B: Condensed Matter (USA),* 42(1): 475-492 (1 Jul 1990).

To the conventional Peierls-Hubbard model, involving both on-site (U) and nearest-neighbor (V) Coulomb repulsions, we add "off-diagonal" terms, not expressible purely in terms of site densities, representing bond-bond (W) and mixed bond-site (X) electron-electron repulsive interactions involving nearest neighbors. We review earlier analyses of these interactions and discuss relative magnitudes of the parameters in applications to real materials. As a specific illustration, we investigate the effects of the off-diagonal W and X terms on dimerization in the one-dimensional, half-filled-band Peierls-Hubbard models, which have been widely applied to conjugated polymers (such as trans-polyacetylene) and to related quasi-one-dimensional charge-density wave (CDW) systems. Using both weak- and strong-coupling perturbation theory for large systems and exact diagonalizations of small systems, we investigate thoroughly the nature of the ground state of the model. For a broad range of the site-diagonal Hubbard parameters (U,V), including the values believed to be relevant to trans-polyacetylene, we find that the off-diagonal terms (W,X) initially *enhance* dimerization, thereby stabilizing the dimerized [or bond-order-wave (BOW)] ground state. For (unphysically) large values of W relative to U and V, dimerization is destroyed, and the BOW ground state goes over to a ferromagnetic ground state or a CDW ground state, depending on the relative sizes of U, V, and W. We conclude with a general discussion of the applicability of the Peierls-Hubbard models to quasi-one-dimensional materials, including the potential importance of the breaking of charge conjugation ("particle-hole") symmetry by the X term.

52303 **Phase Hamiltonian and depinning electric field in the charge-density wave and the spin-density wave.** Maki, K. (Department of Physics, University of Southern California, Los Angeles, CA (USA)); Virosztek, A. *Physical Review, B: Condensed Matter (USA),* 42(1): 655-659 (1 Jul 1990). DOE Contract FG05-84ER45113.

Making use of the phase Hamiltonian derived from microscopic models, we study theoretically the threshold electric field when the charge-density wave (CDW) or the spin-density wave starts sliding. Unlike earlier phenomenological models, we can describe the temperature dependence of the threshold field. Most of experimental results on the threshold field in quasi-one-dimensional CDW's are interpreted in terms of the three-dimensional CDW. Curious exceptions are the CDW's in $NbSe_3$, which appear to be described better by the two-dimensional CDW.

52304 **Electron transport in the presence of a Coulomb field.** Burgdoerfer, J. (Department of Physics, University of Tennessee, Knoxville, Tennessee 37996-1200 (USA)); Gibbons, J. *Physical Review, A (General Physics) (USA),* 42(3): 1206-1221 (1 Aug 1990). DOE Contract AC05-84OR21400.

We analyze the modifications of the transport behavior of electrons in dense media due to the presence of a strong Coulomb field generated by an ion moving initially in close phase-space correlation with the electrons. These modifications play a profound role in convoy electron emission in ion-solid collisions. The transport behavior is studied within the framework of a classical phase-space master equation. The nonseparable master equation is solved numerically using test-particle discretization and Monte Carlo sampling. In the limit of vanishing Coulomb forces the master equation becomes separable and can be reduced to standard one-dimensional kinetic equations for free-electron transport that can be solved exactly. The comparison to free-electron transport is used to gauge both the reliability of test-particle discretization and the significance of Coulomb distortion of the distribution functions. Applications to convoy-electron emission are discussed.

52305 **Kinetics of short- and long-range B2 ordering in the pair approximation.** Fultz, B. (Department of Materials Science 138-78, California Institute of Technology, Pasadena, California 91125 (USA)). *Journal of Materials Research (USA),* 5(7): 1419-1430 (Jul 1990). DOE Contract FG03-86ER45270.

The kinetic master equation is developed in the pair approximation to study disorder→B2 order transformations in bcc binary alloys. Coupled sets of rate equations for the pair variables are obtained for atom movements by either the direct interchange mechanism or the vacancy mechanism. Numerical integrations provide the nonequilibrium relaxations of short- and long-range order (SRO and LRO), and the vacancy balances between the two sublattices. For binary alloys, disorder→order transformations were studied for all combinations of interatomic interaction strengths, activation barrier heights, and alloy stoichiometry variations. After a transient vacancy relaxation, all cases began with a quick relaxation of SRO, followed later and independently by the growth of LRO and additional SRO. There were some variations in kinetic path through SRO and LRO, moderate variations in overall kinetics, and large variations in vacancy balance. Some non-physical aspects of kinetics in the pair approximation are discussed.

52306 **Two semiempirical expressions for condensed-phase heat capacities.** Tsao, J.Y. (Sandia National Laboratories, Albuquerque, New Mexico 87185-8500 (USA)). *Journal of Applied Physics (USA),* 68(4): 1928-1930 (15 Aug 1990). DOE Contract AC04-76DP00789.

We propose two semiempirical expressions for representing condensed-phase heat capacities over a wide temperature range. Both can be integrated analytically to give closed-form expressions for entropies and enthalpies. As examples, we use the expressions to represent the molar heat capacities, entropies, and enthalpies of ⟨Si⟩ and ⟨Al⟩.

52307 **Ion-surface interaction system (ISIS) for the study of redeposited materials: An application of decelerated ion beams with quartz-crystal microbalances.** Youchison, D.L. (Department of Nuclear Engineering, The Pennsylvania State University, University Park, PA (USA)); Nahemow, M.D. *Review of Scientific Instruments (USA),* 61(8): 2184-2193 (Aug 1990).

The ion-surface interaction system (ISIS) is a facility developed for the study of redeposited fusion impurity control surfaces. It was designed to investigate variations in the sputtering yield and surface binding energy caused by alterations to the surface microstructure. ISIS can create redeposited films similar to that found on tokamak limiters continuously sputtering a target at incident energies representative of a tokamak edge plasma. A duoplasmatron ion source is used to produce well-focused, mass-analyzed 30-keV particle beams of H^+ to Xe^+ with fluxes of 1E15 to 7E15 ions/cm^2 s. These beams are decelerated to the 100–1000 eV range before target impact with currents from 50 to 900 μA. The sputtered neutrals are ionized, accelerated to the incident sputtering energy, and deposited onto another target substrate in a controlled background. The deposited film is then sputtered *in situ* to determine changes in sputtering yield and surface binding energy. The sputtering and redeposition of the ionized sputtered particles is monitored via a unique dual quartz-crystal-microbalance apparatus. As many as eight samples are accommodated in this apparatus by a carousel arrangement that facilitates the redeposition while permitting the exchange of crystals (targets) under vacuum. Targets may be either bulk samples or films evaporated onto planar 4.4-MHz AT-cut quartz crystals. The system is complete with computerized data acquisition, residual gas analysis, and multiple current transducers.

6561 Superconductivity

Refer also to citation(s) 51120, 51127, 51169, 51170, 51171, 51172, 51173, 51178, 51179, 51183, 51184, 51185, 51187, 51188, 51189, 51194, 51196, 51215, 51219, 51220, 51223, 51226, 51228, 51229, 51236, 51257, 51273, 51419, 51420, 51438, 51443, 51472, 51473, 51580

52308 (BNL–45146) **Some aspects of the theory of high temperature superconductors.** Emery, V.J. Brookhaven National Lab., Upton, NY (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. DOE/ER. (CONF-900806–10: 19. international conference on low temperature physics, Brighton (UK), 16-22 Aug 1990). Order Number DE91000903. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A qualitative survey of the theory of high temperature superconductors as strongly correlated electron systems is presented. Various microscopic models and their implications for the theory of the normal state are described. Constraints on the mechanism and many body theory of the superconducting state are discussed.

52309 (IC–90/101) **Correlations between frequency of infrared active vibrational modes and copper-oxygen distance in copper oxides, application to superconductors.** Ganguly, P. (International Centre for Theoretical Physics, Trieste (Italy)); Infante, C.; Siddiqi, S.A.; Sreedhar, K. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 26p. Order Number DE91603026. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The infra-red spectra of a large number of ternary Cu(II) oxides with at least a quasi square-planar coordination of oxygen around the copper ions have been studied. The frequency of the bands with the highest frequency, υ_{max}, is found to correlate extremely well with the shortest Cu-O distance. υ_{max} increases at an impressive rate of $\approx$ 20 cm^{-1} per .01 A when the Cu-O distance becomes less than 1.97 A, which is the Cu^{2+}-O^{2-} distance in square-planar CuO_4 complexes as obtained from empirical ionic radii considerations. The marked sensitivity may be used as a "titration" procedure not only to assign bands but also to obtain diagnostic information about local coordination in compounds derived, for example, from the $YBa_2Cu_3O_{7-d}$ structure such as $LaCaBaCu_3O_{7-d}$. The only example where this correlation fails is in the two-layer non-superconducting oxides derived from $La_2(Ca,Sr)Cu_2O_5$. the significance of this result is discussed. The marked dependence of frequency on the bond-distance is qualitatively examined in terms of an increased electron-phonon coupling to account for the observed tendency of the superconducting transition temperature to go through a maximum as the average basal plane Cu-O distance is decreased. (author). 52 refs, 6 figs.

52310 (IS-T–1410) **High-resolution angle-resolved photoemission studies of high $T_c$superconductor $Bi_2Sr_2CaCu_2O_8$.** Liu, Rong. Ames Lab., IA (USA). 21 Sep 1990. 71p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE91000662. Source: NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

An angle-resolved photoemission study of the normal and superconducting states in $Bi_2Sr_2CaCu_2O_8$ was performed. Measurements in the normal state show bands dispersing through the Fermi level from at least 350 meV below E_F. The Fermi level crossings are consistant with local-density band calculation, including a point calculated to be of Bi-O character. Additional measurements were made where bands crossed the Fermi level between 100 and 250K, along with measurements on an adjacent Pt foil. The Fermi edges of both materials agree to within the noise. Below the Fermi level, the spectra show correlation effects on the form of an increased effective mass. The shape of the spectra can be explained by a lifetime-broadened photohole and secondary electrons. The effective inverse photohole lifetime is linear in energy. A superconducting gap has been measured at a number of points where there is density at the Fermi level in the normal state. By proper modeling, a gap of 24 meV was obtained for all these points, including points of Cu-O and Bi-O character respectively, according to band calculation. The lack of gap anisotropy in the basal plane suggests that pinning in this material is not d-wave pairing.

52311 (KFTI–88-20) **Critical temperature in the two-zone superconductor model with account of Coulomb repulsion.** Poluehktov, Yu.M. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 8p. (In Russian). Order Number DE91603027. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Superconductor model with two overlapped conductivity resions taking into account both electron-phonon attraction of electrons and their Coulomb repulsion is considered. It is shown that in case when superconductivity occurrence is mainly due to interband scattering processes and Coulomb interaction is defining superconductor critical temperature may sufficiently exceed the critical point possible in electron-phonon interaction. In case of one band and ignoring the Coulomb interaction the obtained formulas are transformed to the earlier known results. 10 refs.

52312 (LBL–26455, pp. 61) **Nonlinear excitations in solid-state systems.** Jeffries, C.D. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

The central objectives of this program are to experimentally study nonlinear phenomena in solid-state systems and to develop models that can explain and predict the observed behavior. This report describes experiments and analysis of spin waves in ferrites and of plasma waves in Ge rods. Present emphasis is on the novel nonlinear electrodynamics exhibited by high-temperature superconductors of the copper oxide type. The origin of the nonlinearities lies in the microstructures of these ceramic materials: superconducting grains in contact through weak links. Observed generic behavior includes very high-order odd harmonic generation in zero dc field; even harmonics in nonzero field; and, at high harmonics and high pump power, very sharp power dips periodic in the dc field, due to flux quantization. Models are developed that semiquantitatively explain the observed behavior and help characterize the material. This work has a bearing on the problem of high critical currents in high magnetic fields, as well as on the origin of the superconductivity.

52313 (LBL–26455, pp. 62) **Harmonic generation and flux quantization in granular superconductors.** Lam, Q.H.; Jeffries, C.D. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Simple dynamical models of granular superconductors are used to compute the generation of harmonic power in ac and dc magnetic fields. In zero order, the model is a single superconducting loop, with or without a weak link. The sample-average power is predicted by averaging over suitable distribution functions for loop areas and orientations in a dc magnetic field. In a first-order model, inductance and resistance are also included. In all models the power at high harmonics shows strikingly sharp dips periodic in the dc field, revealing flux quantization in the prototype loops.

52314 (LBL–26455, pp. 62) **Nonlinear electrodynamics in the granular superconductor $YBa_2Cu_3O_7$: Experiments and interpretation.** Jeffries, C.D.; Lam, Q.H.; Kim, Y.; Kim, C.M.; Zettl, A.; Klein, M.P. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

For bulk samples of superconducting $YBa_2Cu_3O_7$ powder and pellets subject to a dc magnetic field H_0 and a parallel ac magnetic fields H_1 at frequency $f \sim 10^3$ to 10^5 Hz, the authors report data on the generated harmonic power P(nf) up to harmonic $n \approx 40$, finding: (1) if $H_0 = 0$, only odd harmonic are generated; (2) if $H_0 = 0$, even harmonics are additionally generated; (3) for H_1 sufficiently large ($\gtrsim$ 10 Oe) and n large, then P(nf) vs H_0 displays sharp and deep periodic dips, revealing a remarkably consistent and reproducible macroscopic flux quantization for the bulk sample. These data, as well as the relative intensities of the harmonic power, are found to be in semiquantitative agreement with detailed numerical predictions of a dynamical model of the material as a suitably averaged ensemble of prototype flux quantized loops with weak links. At lower values of H_1, additional structure is observed, related to fluxon pinning and depinning.

52315 (LBL–26455, pp. 62-64) **Work in progress.** Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

Much remains to be done to understand the complex and interesting problem of the electrodynamics of granular superconductors. The phenomena reported here are believed to be generic to $YBa_2Cu_3O_7$. Similar studies are under way on other compounds (e.g., $Bi_4Sr_3Cu_7O_x$), as well as on a variety of forms, including

films, single crystals, and powders and sintered pellets with different grain sizes and methods of preparation. The harmonic-generation studies are sensitive probes of the electrodynamic properties and the microstructure, and may be useful in characterizing materials. The theoretical models are being broadened to take account of the sample geometry, critical state, and fluxon pinning and motion.

52316 (PB–90-253790/XAB) **High-temperature superconductivity in perspective.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Apr 1990. 138p. (OTA-E–440). Source: NTIS, PC A07/MF A01.

Also available from Supt. of Docs. See also PB–90-189648.

The report focuses on the technology of superconductivity and its potential applications and warns that U.S. companies are investing less than their main foreign competitors in both low- and high-temperature superconductivity R&D. This is by far the most critical issue affecting the future U.S. competitive position in superconductivity, and in many other emerging technologies. The chapter headings include the following: Executive summary; High-temperature superconductivity–A progress report; Applications of superconductivity; The U.S. response to high-temperature superconductivity; High-temperature superconductivity programs in other countries; Comparison of industrial superconductivity R&D efforts in the United States and Japan–An OTA survey; Policy issues and options.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 51382, 51450, 51460, 51478, 51495, 51959, 51970, 51980, 52077, 52089, 52126, 52128, 52130, 52132, 52135, 52139, 52141, 52142, 52143, 52146, 52150, 52233, 52409, 52582

52317 (BONN-AM–90-05) **Adiabatic evolution, quantum phases, and Landau-Zener transitions in strong radiation fields.** Breuer, H.P.; Dietz, K.; Holthaus, M. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Jul 1990. 18p. (CONF-9006203–:). Order Number DE91706306. Source: NTIS (US Sales Only), PC A03/MF A01.

We develop a method that allows the investigation of adiabatic evolution in periodically driven quantum systems. It is shown how Berry's geometrical phase emerges in quantum optics. We analyse microwave experiments performed on Rydberg atoms and suggest a new, non-perturbative mechanism to produce excited atomic states. (orig.).

52318 (IC–89/281) **Metric equations in geometry and their applications.** Yang Lu (La Trobe Univ., Bundoora (Australia). Dept. of Mathematics); Zhang Jingzhong. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 18p. Order Number DE91602693. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

As the generalization of the well-known Cayley-Menger algebra, the general relation among points, hyperplanes and hyperspheres in E^n is proposed. A series of examples are given to show its applications. This study would be greatly helpful to symbolic computation in geometry, including computer-aided geometric reasoning. (author). 9 refs.

52319 (IC–90/44) **Effective actions of 2+1 dimensional gravity and BF theory.** Oda, I. (Chiba Univ. (Japan). Dept. of Physics); Yahikozawa, S. International Centre for Theoretical Physics, Trieste (Italy). Apr 1990. 39p. Order Number DE91602722. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We develop the perturbation theory of the BF theory, which is equivalent to 2+1 dimensional gravity without a cosmological constant if we take SO(1,2) as the gauge group. We show that the BF theory, which may have a Chern-Simons term, has only tree- or one loop connected Feynman diagrams and that the theory is completely finite (at all orders). We evaluate the effective actions of the BF theory and the generalized BF theory which has a 'cosmological constant' and show that quantum corrections lead to 'Chern-Simons terms', using a BRST invariant regularization based on Pauli-Villars. (author). 19 refs, 4 figs, 2 tabs.

52320 (IC–90/46) **Harmonicity on the tangent bundle.** Vazquez-Abal, M.E. International Centre for Theoretical Physics, Trieste (Italy). Apr 1990. 6p. Order Number DE91602700. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In the case of real functions of several variables harmonicity of the function implies harmonicity of the components and therefore the property extends to the differential as a function between the corresponding tangent bundles. This problem can be open to arbitrary Riemannian (or pseudo-Riemannian) manifolds (M,g) and (N,h), considering on its tangent bundles TM and TN the corresponding complete lift metrics g^C and h^C respectively. We obtain that the harmonicity of of the maps f: $(M,g)\rightarrow(N,g)$ is equivalent to the harmonicity of the df: $(TM,G^C)\rightarrow(TN,h^C)$. This result gives examples of harmonic maps between pseudo-Riemannian manifolds. (author). 4 refs.

52321 (IC–90/48) **Pattern formation in reaction diffusion systems with finite geometry.** Borzi, C. (International Centre for Theoretical Physics, Trieste (Italy)); Wio, H. International Centre for Theoretical Physics, Trieste (Italy). Apr 1990. 8p. Order Number DE91602701. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We analyze the one-component, one-dimensional, reaction-diffusion equation through a simple inverse method. We confine the system and fix the boundary conditions as to induce pattern formation. We analyze the stability of those patterns. Our goal is to get information about the reaction term out of the preknowledgment of the pattern. (author). 5 refs.

52322 (IC–90/63) **The local structure of a Liouville vector field.** Ciriza, E. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 20p. Order Number DE91602702. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this work we investigate the local structure of a Liouville vector field ξ of a Kaehler manifold (P,Ω) which vanishes on an isotropic submanifold Q of P. Some of the eigenvalues of its linear part at the singular points are zero and the remaining ones are in resonance. We show that there is a C^1-smooth linearizing conjugation between the Liouville vector field ξ and its linear part. To do this we construct Darboux coordinates adapted to the unstable foliation which is provided by the Centre Manifold Theorem. We then apply recent linearization results due to G. Sell. (author). 11 refs.

52323 (IC–90/76) **The subgroups in the special linear group over a skew field that contain the group of diagonal matrices.** Bui Xuan Hai. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 16p. Order Number DE91602703. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For an arbitrary skew field T we study the lattice of subgroups of the special linear group $\Gamma=SL(n,T)$ that contain the subgroup Δ-SD(n,T) of diagonal matrices with Dieudonne's determinant equal to 1. We show that the description of these subgroups is standard in the following sense: For any subgroup $H,\Delta\leq H\leq\Gamma$ there exists a unique unital net such that $\Gamma(\sigma)\leq H\leq N(\sigma)$, where $\Gamma(\sigma)$ is the net subgroup that corresponds to the net σ and $N(\sigma)$ is the normalizer of $\Gamma(\sigma)$ in Γ. (author). 11 refs.

52324 (IC–90/79) **The normal holonomy group.** Olmos, C. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 10p. Order Number DE91602704. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The restricted holonomy group of a Riemannian manifold is a compact Lie group and its representation on the tangent space is a product of irreducible representations and a trivial one. Each one of the non-trivial factors is either an orthogonal representation of a connected compact Lie group which acts transitively on the unit sphere or it is the isotropy representation of a single Riemannian symmetric space of rank ≥ 2. We prove that, all these properties are also true for the representation on the normal space of the restricted normal holonomy group of any submanifold of a space of constant curvature. 4 refs.

52325 (IC–90/84) **On the holonomy group of the normal connection.** Olmos, C. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 10p. Order Number DE91602705. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this note we are concerned with the problem of irreducible s-representations which can occur as normal holonomy representations of submanifolds of the sphere. We show that almost all s-representations of rank ≥ 2 do actually occur in this way. We study the normal holonomy group of (singular) orbits of s-representations (the so called imbedded R-spaces). 11 refs.

52326 (IC–90/88) **On behaviour of Weyl's gauge field.** Yuan Zhong Zhang. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 19p. Order Number DE91602723. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We consider a system, consisting of a metric tensor $g_{\mu\nu}$, a scalar field ϕ, a Weyl's gauge field A_μ and a scalar matter field Φ, which is invariant under general coordinate transformation and Weyl's gauge transformation. Two kinds of identities and field equations are given and discussed. A special space-time with $g_{\mu\nu}=\phi^{-2}\eta_{\mu\nu}$ is considered in a gauge-independent manner. We point out that in a correct treatment where $g_{\mu\nu}$ is not regarded as an independent variable, an auxiliary condition for Weyl's gauge field cannot be obtained. Therefore Weyl's gauge field can be treated as a usual field of positive norm. (author). 11 refs.

52327 (IC–90/99) **Quantum theory of single events: Localized de Broglie-wavelets, Schroedinger waves and classical trajectories.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 8p. Order Number DE91602710. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For an arbitrary potential V with classical trajectories x-vector=g-vector(t) we construct localized oscillating three-dimensional wave lumps ψ(x-vector,t,g-vector) representing a single quantum particle. The crest of the envelope of the ripple follows the classical orbit g-vector(t) slightly modified due to potential V and ψ(x-vector,t;g-vector) satisfies the Schroedinger equation. The field energy, momentum and angular momentum calculated as integrals over all space are equal to particle energy, momentum and angular momentum. The relation to coherent states and to Schroedinger waves are also discussed. (author). 6 refs.

52328 (IC–90/105) **The Hopf fibration over S^8 admits no S^1-subfibration.** Loo, B.; Verjovsky, A. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 20p. Order Number DE91602694. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that there does not exist a PL-bundle over S^8 with fibre and total space PL-manifolds homotopy equivalent to CP^3 and CP^7 respectively. Consequently, the Hopf fibration over S^8 admits no subfibration by PL-circles. (author). 27 refs.

52329 (IC–90/106) **Frenet's formulae viewed diagrammatically by the Darboux vector.** Rahman, M.S. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 4p. Order Number DE91602695. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Using the Darboux vector, Frenet's formulae for space curves, plane curves and straight lives are presented in a pattern which makes their mathematical concepts more tangible. 2 refs, 3 figs.

52330 (IC–90/107) **On the role of the Chern-Simons action for the description of the QHE.** Cabo, A. (International Centre for Theoretical Physics, Trieste (Italy)); Oliva, D. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 16p. Order Number DE91602707. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The role of the Chern-Simons action in the description of the quantum Hall effects is stressed. The 2D-electromagnetic picture of Widom and Srivastava is shown to be valid in a superlattice of 2D-electron gases. A Meissner-like effect appears in such systems. In them, the difference between the external and the integer filling factor fields is exponentially screened by the surface (edge) currents. Also, effective Maxwell equations for one sheet or a superlattice are obtained. (author). 21 refs.

52331 (IC–90/108) **Relativistic quantum Hall conductivity for 3D and 2D electron plasma in an external magnetic field.** Gonzalez Felipe, R. (Grupo de Fisica Teorica ICIMAF, Vedado, La Habana (Cuba)); Perez Martinez, A.; Perez-Rojas, H. International Centre for Theoretical Physics, Trieste (Italy). May 1990. 9p. Order Number DE91602708. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The complete antisymmetric form of the conductivity tensor in the static limit, as well as the expression for the Hall conductivity, is obtained for the relativistic 3D and 2D electron gas in a magnetic field. The non-relativistic 2D limit is also discussed. The typical step form of the 2D Hall conductivity at zero temperature is obtained under the simple hypothesis of constancy of the chemical potential. (author). 6 refs, 1 fig.

52332 (IC–90/110) **Extendibility of isoparametric submanifolds.** Olmos, C. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 5p. Order Number DE91602696. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The purpose of this note is to prove that an isoparametric submanifold of the Euclidean space is always contained in a complete one. This is achieved by an inductive argument on the codimension. The method used also gives a simple construction for the Weyl group and a reduction to the spherical case. 7 refs.

52333 (IC–90/112) **A viewpoint on nearly conformally symmetric manifold.** Rahman, M.S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 10p. Order Number DE91602697. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Some observations, with definition, on Nearly Conformally Symmetric (NCS) manifold are made. A number of theorems concerning conformal change of metric and parallel tensors on NCS manifolds are presented. It is illustrated that a manifold $M = R^{n-1} \times R_+^1$, endowed with a special metric, is NCS but not of harmonic curvature. (author). 8 refs.

52334 (IC–90/117) **L^p continuity of conditional expectations.** Brambila-Paz, F. (International Centre for Theoretical Physics, Trieste (Italy)); Alonso, A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 16p. Order Number DE91602698. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A necessary and sufficient condition over a sequence $\{A_n\}_n$ is an element of N of σ-subalgebras that assures L^p-convergence of the conditional expectations will be given. The result generalizes the L^p-martingales, O'Reilly-Fetter and Boylan (equiconvergence) theorems. (author). 5 refs.

52335 (IC–90/120) **Decomposable spaces of recurrent conformal curvature.** Rahman, M.S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 8p. Order Number DE91602699. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Definitions of a decomposable space, decomposition spaces and a space of recurrent conformal curvature are given. A decomposable space of recurrent conformal curvature V_n, (shortly CK_n) is looked upon as decomposition spaces V_r and V_{n-r}. With this concept some results on decomposable CK_n are derived. (author). 5 refs.

52336 (IC–90/124) **Centrifugal force in Ernst spacetime.** Prasanna, A.R. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 11p. Order Number DE91602720. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this we show that in Ernst spacetime which represents the gravitational field of a mass embedded in a magnetic filed, the centrifugal force acting on a particle in circular orbit, reverses its sign twice, once very close to r=3m, and again later at a distance far away from the centre, depending upon the combined values of M and B, the mass and the strength of the magnetic field. The second reversal would mean that beyond a certain distance, depending upon Bm, in Ernst geometry, no Keplerian motion is possible for test particle. This result may have some possible astrophysical consequence. (author). 9 refs, 4 figs.

52337 (IC–90/137) **Covariant formulation of multiple localized quantum measurements.** Diosi, L. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 17p. Order Number DE91602709. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have considered the dynamics of simple measuring devices coupled to quantized relativistic Heisenberg-fields. We have defined localized observables and derived covariant equations for the joint probability distribution of the measured outcomes. The proposed formalism is based on standard field-theoretical terms. We have shown that our formalism yields the expected anti-coincidence when two devices detect two wavepackets of a single electron. Applications in the measurement theory of vacuum fluctuations have been suggested. (author). 6 refs, 1 fig.

52338 (IC–90/143) **Is the propagation of electromagnetic radiation in cosmological backgrounds in agreement with the standard model?.** Souza, J.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1990. 7p. Order Number DE91602721. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We have found the conditions which a background metric must obey in order that Maxwell equations have a solution depending harmonically on time in it. In particular, for the standard model, these solutions do not exist. (author). 3 refs.

52339 (INS–829) **Space-time dimension of the universe.** Terazawa, Hidezumi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jun 1990. 16p. Order Number DE91712982. Source: NTIS (US Sales Only), PC A03/MF A01.

Among the three paradigms in which the space-time dimension may be determined, mainly discussed is the one in which the space-time dimension can be taken as a 'dynamical variable' to be determined by the 'Hamilton principle' of minimizing the extended n-dimensional Einstein-Hilbert action of gravitation. (author).

52340 (LAFI–153) **Davydov solitons in chains with quartet anharmonicity.** Kashcheev, V.N. AN Latvijskoj SSR, Riga (USSR). Inst. Fiziki. 1989. 16p. (In Russian). Order Number DE91602706. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Solitary nonlinear waves formed in monomolecular chains with quartet anharmonicity due to the electron interactions with acoustic vibrations of chains are considered. In terms of the Weierstrass elliptic functions periodic solutions have been derived to the corresponding Davydov equations for the modulus of the electron wave function and relative distortion of the chain. Localized solutions of these equations corresponding to the solitons have been found as well. Types of solitary waves corresponding to arbitrary chain anharmonicity have been analyzed. 7 refs.

52341 (LA-UR–90-2947) **Special functions associated with SU(3) Wigner-Clebsch-Gordan coefficients.** Louck, J.D.; Biedenharn, L.C. Los Alamos National Lab., NM (USA). [1990]. 27p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9009265–1: School on symmetry and structural properties on condensed matter, Poznan (Poland), 6-12 Sep 1990). Order Number DE91000446. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Wigner-Clebsch-Gordan (WCG) coefficients of the unitary groups are a rich source of multivariable special functions. The general algebraic setting of these coefficients is reviewed and several special functions associated with the SU(3) WCG coefficients defined and their properties presented. 29 refs.

52342 (LA-UR–90-3055) **Benchmark studies of the Bending Corrected Rotating Linear Model (BCRLM) reactive scattering code: implications for accurate quantum calculations.** Hayes, E.F. (Rice Univ., Houston, TX (USA). Dept. of Chemistry); Darakjian, Z.; Walker, R.B. Los Alamos National Lab., NM (USA). [1990]. 27p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9008159–1: Conference on parallel computation for reaction dynamics, Perugia (Italy), 30 Aug - 1 sep 1990). Order Number DE91000365. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Bending Corrected Rotating Linear Model (BCRLM), developed by Hayes and Walker, is a simple approximation to the true multidimensional scattering problem for reaction of the type: A + BC → AB + C. While the BCRLM method is simpler than methods designed to obtain accurate three dimensional quantum scattering results, this turns out to be a major advantage in terms of our benchmarking studies. The computer code used to obtain BCRLM scattering results is written for the most part in standard FORTRAN and has been reported to several scalar, vector, and parallel architecture computers including the IBM 3090-600J, the Cray XMP and YMP, the Ardent Titan, IBM RISC System/6000, Convex C-1 and the MIPS 2000. Benchmark results will be reported for each of these machines with an emphasis on comparing the scalar, vector, and parallel performance for the standard code with minimum modifications. Detailed analysis of the mapping of the BCRLM approach onto both shared and distributed memory parallel architecture machines indicates the importance of introducing several key changes in the basic strategy and algorithums used to calculate scattering results. This analysis of the BCRLM approach provides some insights into optimal strategies for mapping three dimensional quantum scattering methods, such as the Parker-Pack method, onto shared or distributed memory parallel computers.

52343 (LA-UR–90-3249) **Applications of Maxent to quantum Monte Carlo.** Silver, R.N. (Los Alamos National Lab., NM (USA)); Sivia, D.S.; Gubernatis, J.E.; Jarrell, M. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-9007172–2: MAXENT '90: maximum entropy workshop, Laramie, WY (USA), 30 Jul - 3 aug 1990). Order Number DE91000216. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We consider the application of maximum entropy methods to the analysis of data produced by computer simulations. The focus is the calculation of the dynamical properties of quantum many-body systems by Monte Carlo methods, which is termed the "Analytical Continuation Problem." For the Anderson model of dilute magnetic impurities in metals, we obtain spectral functions and transport coefficients which obey "Kondo Universality." 24 refs., 7 figs.

52344 (LA-UR–90-3344) **Antimatter gravity experiment.** Brown, R.E.; Camp, J.B.; Darling, T.W. Los Alamos National Lab., NM (USA). [1990]. 10p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-901116–4: 11. international conference on the application of accelerators in research and industry, Denton, TX (USA), 5-8 Nov 1990). Order Number DE91000177. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An experiment is being developed to measure the acceleration of the antiproton in the gravitational field of the earth. Antiprotons of a few MeV from the LEAR facility at CERN will be slowed, captured, cooled to a temperature of about 10 K, and subsequently launched a few at a time into a drift tube where the effect of gravity on their motion will be determined by a time-of-flight method. Development of the experiment is proceeding at Los Alamos using normal matter. The fabrication of a drift tube that will produce a region of space in which gravity is the dominant force on moving ions is of major difficulty. This involves a study of methods of minimizing the electric fields produced by spatially varying work functions on conducting surfaces. Progress in a number of areas is described, with stress on the drift-tube development.

52345 (LBL–29312) **Current and potential distributions on a cylinder electrode.** Grabowski, A.J. Lawrence Berkeley Lab., CA (USA). Jul 1990. 92p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE91000170. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This work presents the numerical solution for the current and potential distributions of a cylindrical electrode. In particular, it investigates the primary current distribution, the secondary current distribution with linearized kinetics, and the potential distribution due to constant current density on the working electrode. 16 refs., 19 figs.

52346 (PHE–86-13, pp. 206-214) **Einstein causal quantum fields on lattices with discrete Lorentz invariance.** Baumgaertel, H. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Karl-Weierstrass-Inst. fuer Mathematik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the*

theory of elementary particles. 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Results on rigorous construction of quantum fields on the hypercubic lattice Z^4 considered as a lattice in the Minkowski space R^4 are presented. Two associated fields are constructed: The first one having on the lattice points of Z^4 is causal and Poincare invariant in the discrete sense. The second one is an interpolating field over R^4 which is pointlike, translationally covariant and spectral in such a manner that the 'real' lattices field is the restriction of the interpolating field to Z^4. Furthermore, results on a rigorous perturbation theory of such fields are mentioned.

52347 (PHE–86-13, pp. 226-243) **Two cosmological aspects of interacting quantum field theory: Particle production and CPT non-invariance.** Lotze, K.H. (Jena Univ. (German Democratic Republic). Sektion Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The electromagnetic and the π^0 - 2γ - model interactions are investigated in spatially flat Robertson-Walker universes. Simultaneous creation of photons and electron-positron pairs as well as the decays $\gamma \rightarrow e^+e^-$ and $\pi^0 \rightarrow 2\gamma$ are studied in detail. It is found that the electromagnetic interaction is a source of cosomological photons and that the creation of 'free' Dirac particles exerts an attenuating influence on their production due to interaction with photons. Both decay processes are not CPT invariant if (i) the expansion of the universe provides a T-asymmetric background and (ii) the conditions for free-particle creation are fulfilled for at least one quantum field participating in the interactions. (author).

52348 (PHE–86-13, pp. 244-255) **On the Schwinger-De Witt expansion for the Feynman propagator in a curved space-time.** John, R.W. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Zentralinstitut fuer Astrophysik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

The Feynman propagator in curved space-time is defined in a manifestly covariant way by the help of the Schwinger-De Witt representation. Building elements of the Schwinger-De Witt expansion are obtained on a model space-time being of non-constant curvature and yielding not identically vanishing Hadamard coefficients. The world function can be calculated exactly and in closed form for special representatives of highly symmetric space-time only.

52349 (PHE–86-13, pp. 256-270) **Quantum theory of gauge fields in Robertson-Walker spacetime.** Basler, M. (Jena Univ. (German Democratic Republic). Sektion Physik). Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik. Dec 1986. (CONF-8610472–: International symposium on the theory of elementary particles, Ahrenshoop (German Democratic Republic), 13-17 Oct 1986). In *Proceedings of the 20. international symposium on the theory of elementary particles.* 405p. Order Number DE90706237. Source: NTIS (US Sales Only), PC A18/MF A01; OSTI; INIS.

Exploiting the Lagrange multiplier formalism developed by Kugo and Ojima we give a canonical quantization scheme for non-Abelian gauge theories in curved spacetime. As a first step in a general study of cosmological particle production we investigate the production of non-interacting particles and show, that unphysical particles are absent from the spectrum of particles produced by the gravitational field. (author).

52350 (UCRL-ID–104090) **REMAP: A computer code that transfers node information between dissimilar grids.** Shapiro, A.B. Lawrence Livermore National Lab., CA (USA). Apr 1990. 26p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000073. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

REMAP is a computer code that transfers the axisymmetric, two dimensional planar, or three dimensional temperature field from one finite element mesh to another. The meshes may be arbitrary as far as the number of elements and their geometry. REMAP interpolates or extrapolates the node temperatures from the old mesh to the new mesh using linear, bilinear, or trilinear isoparametric finite element shape functions. REMAP is used to transfer the temperature field from a thermal analysis mesh to a more finely discretized structural analysis mesh when performing a thermal stress analysis. REMAP was designed to be used with the finite element heat transfer codes TOPAZ2D and TOPAZ3D, and the solid mechanics codes NIKE2D and NIKE3D. The I/O formats in REMAP can be easily modified to accept input from other codes (e.g., finite difference) and generate output files for other structural codes. REMAP can be used to transfer any scalar field variable between dissimilar finite element meshes. The idea of a coarse filter by a fine filter to determine which element from the old mesh contains a node point from the new mesh was used. The coarse filter determines a subset of elements from the old mesh that may contain the new node point. The fine filter determines the element that contains the new node point. REMAP uses the ray-surface intersection algorithm developed for the FACET code for the fine filter. This algorithm has the added capability to determine which element the node is closest to if the node point lies outside the perimeter of the old mesh. Once an element from the old mesh has been identified as containing or closest to the new node point, the natural coordinates for the node point are calculated. The isoparametric finite element shape functions are calculated next. These shape functions are then used to interpolate or extrapolate the temperatures from the nodes comprising the old element to the new node point.

52351 (UCRL-ID–104558) **TOPAZ2D heat transfer code users manual and thermal property data base.** Shapiro, A.B.; Edwards, A.L. Lawrence Livermore National Lab., CA (USA). May 1990. 188p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000075. Source: NTIS, PC A09/MF A01 - OSTI; GPO Dep.

TOPAZ2D is a two dimensional implicit finite element computer code for heat transfer analysis. This user's manual provides information on the structure of a TOPAZ2D input file. Also included is a material thermal property data base. This manual is supplemented with The TOPAZ2D Theoretical Manual and the TOPAZ2D Verification Manual. TOPAZ2D has been implemented on the CRAY, SUN, and VAX computers. TOPAZ2D can be used to solve for the steady state or transient temperature field on two dimensional planar or axisymmetric geometries. Material properties may be temperature dependent and either isotropic or orthotropic. A variety of time and temperature dependent boundary conditions can be specified including temperature, flux, convection, and radiation. Time or temperature dependent internal heat generation can be defined locally be element or globally by material. TOPAZ2D can solve problems of diffuse and specular band radiation in an enclosure coupled with conduction in material surrounding the enclosure. Additional features include thermally controlled reactive chemical mixtures, thermal contact resistance across an interface, bulk fluid flow, phase change, and energy balances. Thermal stresses can be calculated using the solid mechanics code NIKE2D which reads the temperature state data calculated by TOPAZ2D. A three dimensional version of the code, TOPAZ3D is available. The material thermal property data base, Chapter 4, included in this manual was originally published in 1969 by Art Edwards for use with his TRUMP finite difference heat transfer code. The format of the data has been altered to be compatible with TOPAZ2D. Bob Bailey is responsible for adding the high explosive thermal property data.

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Refer also to citation(s) 50990, 51490

52352 (CONF-900918–7) **Overview of the US Magnetic Fusion Energy Program.** Wiffen, F.W. (Oak Ridge National Lab., TN

(USA)); Dowling, R.J.; Marton, W.A.; Eckstrand, S.A. Oak Ridge National Lab., TN (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 16. symposium on fusion technology; London (UK); 3-7 Sep 1990. Order Number DE91000395. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Since the 1988 Symposium on Fusion Technology, steady progress has been made in the US Magnetic Fusion Energy Program. The large US tokamaks have reached new levels of plasma performance with associated improvements in the understanding of transport. The technology support for ongoing and future devices is similarly advancing with notable advances in magnetic, rf heating tubes, pellet injector, plasma interactive materials, tritium handling, structural materials, and system studies. Currently, a high level DOE review of the program is underway to provide recommendations for a strategic plan.

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Refer also to citation(s) 51452, 51453, 51456, 51458, 51470, 51933, 51941, 51977, 51978, 51979, 51981, 52331, 52504, 52505, 52529, 52534, 52544, 52547, 52548, 52549, 52559

52353 (DOE/ER/53175–5) **Collisional processes of interest in MFE plasma research: Annual report, June 1, 1989–May 31, 1990.** Olson, R.E. Missouri Univ., Rolla, MO (USA). Dept. of Physics. 24 May 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER53175. Order Number DE91000598. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Research on this grant is devoted to the calculation of heavy particle collision cross sections needed for diagnostic studies of magnetic fusion plasmas. This work requires the development and testing of new theoretical methods, with the implementation of benchmarked techniques to collisions pertinent to fusion reactors. Within the last context, we have provided charge-exchange-recombination cross sections to specific n,1-levels for diagnostic studies on TFTR and for a major compilation for IAEA. We have also completed a cross section study related to the planned neutral beam current drive for ITER. In addition, calculations were completed to assess the use of He neutral atom angular scattering measurements for JT-60. Also, new theoretical methods have been developed to more accurately calculate cross sections involving either He or H_2 targets and partially stripped multiply-charged ions.

52354 (DOE/ER/53188–7) **Experimental investigations of electron capture from atomic hydrogen and deuterium by alpha particles: Annual progress report, 15 September 1989–14 September 1990.** Missouri Univ., Rolla, MO (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER53188. Order Number DE91000594. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have undertaken a program at the University of Missouri-Rolla to experimentally determine cross sections for ion-atom collisions of interest in fusion reactor development. During the last grant period, we have made measurements of total and singly-differential cross sections for the alpha double-capture reaction. $He^{++} + He(ls^2) \rightarrow He(\Sigma n,\ell) + He^{++}$. Collisions of this type have been discussed as a basis for diagnostics in which alphas are neutralized in a single collisions either by a HeI beam or by the ablative cloud from mechanically introduced impurity pellets. We are now finishing measurements of cross sections for the alpha single capture reaction $He^{++} + He(1s^2) \rightarrow He^{+}(n) + He^{+}(1s)$, and propose to study $He^{++} + H(1s) \rightarrow He^{+}(n) + H^{+}$ during next year. Accurate knowledge of these cross sections is fundamental for modeling of neutral-hydrogen beam penetration in fusion plasmas as well as for spectroscopic diagnostics of alpha densities and velocity distributions, especially for the case of capture into the n = 4 state of the projectile He^{+}. Our measurements are made using a unique collision spectrometer discussed in this paper.

52355 (DOE/ET/53088–455) **Nonlinear saturation of ideal interchange modes in a sheared magnetic field.** Beklemishev, A.D. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Sep 1990. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–455). Order Number DE91000575. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Pressure-driven ideal modes cannot completely interchange flux tubes of a sheared magnetic field; instead, they saturate, forming new helical equilibria. These equilibria are studied both analytically and numerically with reduced MHD equations in a flux-conserving Lagrangian representation. For unstable localized modes, the structure of the nonlinear layer generated around the resonant flux surface depends on the value of Mercier parameter D_M. Its width is found to be proportional to the position of the inflection point on the linear eigenfunction. Perturbed surfaces in equilibrium always have folds, i.e., areas where the direction of the original reduced magnetic field is reserved. But only far from the instability threshold does the internal structure of the nonlinear layer resemble 'bubble' formation. The appearance of sheet currents and island-like structures along the resonant flux surface may be of interest for the description of forced reconnection in models with finite resistivity. Analytic results are found to be in agreement with 2-D numerical simulations. This study also includes the case of ballooning instability by representing nonlocal driving terms through the matching parameter Δ', which defines the outer boundary conditions for the interchange layer. 12 refs., 9 figs.

52356 (GA-A–20099) **Plasma diagnostics for the DIII-D divertor upgrade.** Hill, D.N. (Lawrence Livermore National Lab., CA (USA)); Futch, A.; Buchenauer, D.; Doerner, R.; Lehmer, R.; Schmitz, L.; Klepper, C.C.; Menon, M.; Leikind, B.; Lippmann, S.; Mahdavi, M.A.; Schaffer, M.; Smith, J.; Salmonson, J.; Watkins, J. General Atomics, San Diego, CA (USA). Oct 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114 ;AC05-84OR21400 ;W-7405-ENG-48 ;AC0 (CONF-900557–16: 8. topical conference on high-temperature plasma diagnostics, Hyannis, MA (USA), 6-10 May 1990). Order Number DE91000936. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The DIII-D tokamak is being upgraded to allow for divertor biasing, baffling, and pumping experiments. This paper gives an overview of the new diagnostics added to DIII-D as part of this Advanced Divertor Program. They include tile current monitors, fast reciprocating Langmuir probes, a fixed probe array in the divertor, fast neutral pressure gauges, and H_α measurements with TV cameras and fiber optics coupled to a high resolution spectrometer. 9 refs.

52357 (IAE–4631-6) **Effect of plasma wave dispersion on spatial increment of beam instability.** Kachalov, K.O.; Popkov, N.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 8p. (In Russian). Order Number DE91602942. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Plasma-beam instability of a magnetized ribbon electron beam and warm anisotropic plasma has been investigated. Linear theory of the problem is considered. Dependences of spatial growth rate on the ratio of transverse and longitudinal temperature and beam thickness have been obtained. The growth rate was found to be maximum for the first symmetrical oscillation mode. The parameter characterizing the effect of finite electron beam geometry on the growth rate has been also determined. 5 refs.; 5 figs.

52358 (IAE–4900-7) **Study on superfast deuterium Z-pinch at the ANGARA-5-1 device.** Batyunin, A.V. (and others); Bulatov, A.N.; Vikharev, V.D. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 11p. (In Russian). Order Number DE91602909. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

2-3 MA superfast deuterium Z-pinch with 100 ns pulse rise time is investigated at the ANGARA-5-1 device. The neutron yield in the experiments reaches 10^{12} per pulse. A high axial gradient of the ion number per unit length $dN/dx \simeq 10^{18}$ cm^{-3} results in acceleration of some ions and anisotropy of the neutron energy spectrum. 13 refs.; 4 figs.

52359 (IAEA-CN–53/E-3-11) **Fast-wave current drive modelling for large non-circular tokamaks.** Batchelor, D.B. (Oak Ridge National Lab., TN (USA)); Goldfinger, R.C.; Jaeger, E.F.; Carter, M.D.; Swain, D.W.; Ehst, D.; Karney, C.F.F. Oak Ridge National

Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-901025–9: 13. international conference on plasma physics and controlled nuclear fusion research, Washington, DC (USA), 1-6 Oct 1990). Order Number DE91000562. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

It is widely recognized that a key element in the development of an attractive tokamak reactor, and in the successful achievement of the mission of ITER, is the development of an efficient steady-state current drive technique. Fast waves in the ion cyclotron range of frequencies hold the promise to drive steady-state currents with the required efficiency and to effectively heat the plasma to ignition. Advantages over other heating and current drive techniques include low cost per watt and the ability to penetrate to the center of high-density plasmas. The primary issues that must be resolved are: can an antenna array be designed to radiate the required spectrum of waves and have adequate coupling properties? Will the rf power be efficiently absorbed by electrons in the desired velocity range without unacceptable parasitic damping by fuel ions or α particles? What will the efficiency of current drive be when toroidal effects such as trapped particles are included? Can a practical rf system be designed and integrated into the device? We have addressed these issues by performing extensive calculations with ORION, a 2-D code, and the ray tracing code RAYS, which calculate wave propagation, absorption and current drive in tokamak geometry, and with RIP, a 2-D code that self-consistently calculates current drive with MHD equilibrium. An important figure of merit in this context is the integrated, normalized current drive efficiency. The calculations that we present here emphasize the ITER device. We consider a low-frequency scenario such that no ion resonances appear in the machine, and a high-frequency scenario such that the deuterium second harmonic resonance is just outside the plasma and the tritium second harmonic is in the plasma, midway between the magnetic axis and the inside edge. In both cases electron currents are driven by combined TTMP and Landau damping of the fast waves.

52360 (IPP–5/34) **Scalings and plasma profile parameterisation of ASDEX high density ohmic discharges.** McCarthy, P.J. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Kardaun, O.J.W.F.; Murmann, H.; Lackner, K.; Riedel, K.S. ASDEX Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). May 1990. 52p. Grant DE-FG02-86ER53223. Order Number DE91706328. Source: NTIS (US Sales Only), PC A04/MF A01.

A database of high density ($.3 < \text{anti } n_e/10^{20}\ m^{-3} < .8$), low q_a ($1.9 < q_a < 3.4$), Ohmic discharges from the ASDEX experiment is analysed statistically. Bulk parameter scalings and parameterised temperature and density profile shapes are presented. The total plasma kinetic energy, assuming $T_i = T_e$, scales as anti $n_e^{.54\pm.01}$ $I_p^{.90\pm.04}$ and is independent of B_t. The electron temperature profile peaking factor scales as $T_0^{3/2}/\langle T^{3/2}\rangle = .94\ (\pm^{.04})q_a^{1.07\pm.04}$ in close agreement with the assumption of classical resistive equilibrium. In the inner half of the plasma, the inverse fall-off length for both temperature and density has a strong dependence on q_a, with the temperature dependence being more pronounced. Outside the half radius the q_a dependence disappears but the density profile broadens near the edge with increasing plasma current. A second database of moderate density, moderate q_a discharges is presented for comparison. (orig.).

52361 (IPP–5/35) **A statistical approach to plasma profile analysis.** Kardaun, O.J.W.F. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); McCarthy, P.J.; Lackner, K.; Riedel, K.S. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). May 1990. 43p. Grant DE-FG02-86ER53223. Order Number DE91706329. Source: NTIS (US Sales Only), PC A03/MF A01.

A general statistical approach to the parameterisation and analysis of tokamak profiles is presented. The modelling of the profile dependence on both the radius and the plasma parameters is discussed, and pertinent, classical as well as robust, methods of estimation are reviewed. Special attention is given to statistical tests for discriminating between the various models, and to the construction of confidence intervals for the parameterised profiles and the associated global quantities. The statistical approach is shown to provide a rigorous approach to the empirical testing of plasma profile invariance. (orig.).

52362 (ITEF–71-89) **γ-diagnostics of dense plasma.** Latyshev, S.V.; Rudskoj, I.V.; Cheblukov, Yu.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 7p. (In Russian). Order Number DE91602935. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that by the intensity of γ radiation occuring as a result of heavy ion high-intensity beam interaction with the solid-state target nuclei a conclusion can be made concerning the bremstrahlung properties of plasma produced theirwith. Besides it is stressed that nuclear γ radiation contains information concerning changes of density, scattering during plasma heating. It is shown that at the modern technical level there exists a principle possibility of conducting experiments using nuclear γ radiation for hot solid-state plasma diagnostics. 3 refs.; 1 fig.

52363 (JAERI-M–90-088) **MTX microwave-electric-field diagnostic.** Odajima, Kazuo (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Ohasa, Kazumi; Shiho, Makoto. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 69p. Order Number DE91712986. Source: NTIS (US Sales Only), PC A04/MF A01.

A joint Japan-U.S. project is in progress to measure the high electric fields produced by a free-electron laser beam of GW-peak-power level when injected into the plasma of the Microwave Tokamak Experiment (MTX) at the Lawrence Livermore National Laboratory in California. In this report, we discuss the planned method of measurement and the status of the work. The equipment needed is either well along in the design stage or is being built. We plan to test out the combined operation of all components in Japan before shipping to Livermore. Although the measurement appears difficult for a variety of technical and physics reasons, calculations indicate that it should be possible. (author).

52364 (JAERI-M–90-105) **Design of neutron diagnostic for MTX.** Ogawa, Toshihide (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Oasa, Kazumi; Hoshino, Katsumichi; Odajima, Kazuo; Maeda, Hikosuke. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1990. 22p. Order Number DE91713055. Source: NTIS (US Sales Only), PC A03/MF A01.

A neutron diagnostic system was designed for the Microwave Tokamak Experiment being carried out at the lawrence Livermore National Laboratory. High speed measurements are important to this experiment. Plastic scintillator is used for this fast response detection of neutron. Proportional counters and fission counters are used for the total neutron emission rate measurements. (author).

52365 (KFK–4696) **High resolution shock-capturing scheme for numerical simulation of plasma-shock interaction.** Gupta, N.K.; Munz, C.D.; Goel, B. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik. Apr 1990. 98p. Order Number DE91706327. Source: NTIS (US Sales Only), PC A05/MF A01.

This report describes a one dimensional hydrodynamic computer code in Lagrangean geometry based on high resolution upwind schemes. The code has 1st order as well as 2nd order upwind scheme options and can accomodate any given, analytical or tabular equation of state. The code is tested against a number of test problems for which either analytical or numerical solutions from well tested computer codes or both are available in literature. A brief summary of these comparisons is presented in this report. The predictions of this code are compared with the result of the often used von-Neumann prescription of shock capturing. The results of the present code are free from unphysical oscillations which are typical of von-Neumann procedure. The code is used to simulate the 1-dimensional hydrodynamic and thermodynamic behaviour of plasma irradiated by an intense ion beam. The absence of the spurious oscillations in the results of the present code is especially advantageous to study the effects of temporal non-uniformities of the beam. The second order upwind scheme resolves shocks much steeper than the 1st order one and is therefore recommended for shock wave experiment analysis. For a typical pinch

reflex diode pulse of proton beam on aluminium target upwind results predict compressions of about 10-15% higher as compared to von-Neumann procedure. The upwind results are believed to be closer to reality because this method does not involve any artificial pressure term. (orig.).

52366 (KFTI–88-24) **On a peculiarity of dispersion equation for gyrotropic plasma waveguide.** Onishchenko, I.N.; Sotnikov, G.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 5p. (In Russian). Order Number DE91602949. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Dispersion equation of gyrotropic plasma waveguide for parameter range when transverse wave numbers defining radial field structure are complex is derived. Example of dispersion equation solution is presented. Radial structure of longitudinal electric field in the range of complex and actual arguments of radial functions is presented. 3 refs.; 2 figs.

52367 (KFTI–88-30) **Acceleration of charged particles by plasma oscillations in laminated plasma.** Balakirev, V.A.; Novikov, V.E.; Tkach, Yu.V. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 8p. (In Russian). Order Number DE91602950. Source: NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Dynamics of electron acceleration by periodic sequence of plasma resonances in laminated plasma is studied. For synchronization of oscillation phase in separate resonances their possible excitation by modulated electron beam is considered. Consideration is carried out in the specified beam current approximation. Conditions at which particles fall within conditions of unlimited acceleration are found. 7 refs.; 4 figs.

52368 (KFTI–88-32) **Study on the plasma oscillations in the one-slid electromagnetic trap.** Vdovin, S.A.; Lavrent'ev, O.A.; Storozhenko, Yu.O. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 12p. (In Russian). Order Number DE91602951. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experiments on studying plasma potential oscillations in electromagnetic trap are described. The values of the density gradients, potential and plasma temperature are measured, functional dependences of temperature and potential are studied. Method of correlation analysis is used to determine frequency spectrum of oscillations, phase rate values and direction of oscillation propagation. Two types of instability - a long-wave ion-acoustic and drift low-hybrid one are detected. Anomalous electron transfer results from existence of these instabilities in electromagnetic trap. 10 refs.; 10 figs.

52369 (KFTI–88-39) **Mechanisms of metal impurity release during HF-heating in the URAGAN-3 torsatron.** Grigor'eva, L.I. (and others); Konovalov, V.G.; Kotsubanov, V.D. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 17p. (In Russian). Order Number DE91602922. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Possible mechanisms responsible for the metal impurity release during ICRF production and heating of a plasma are studied with the URAGAN-3 torsatron. It is shown that the edge plasma potential oscillations at the pumping frequency and its harmonics produce an impurity influx from the surface of the helical winding casings (Fe, Cr). The impurity release from the antenna surface (Ti) is caused by a quasisteady ion flux arising in the divertor magnetic flux region during the RF pulse. 21 refs.; 11 figs.

52370 (LA-UR–90-3345) **Complete fluid equations for low-n singular modes in axisymmetric toroidal plasmas.** Glasser, A.H. Los Alamos National Lab., NM (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900807–1: Joint Varenna-Lausanne international workshop on theory of fusion plasmas, Varenna (Italy), 27-31 Aug 1990). Order Number DE91000176. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The goal of this work is to develop a complete linear theory of the singular region, including all important dynamical effects. The present phase of the work treats the more collision fluid regime. A later phase will treat the less collisional gyrokinetic regime. This paper concerns the derivation and form of the fluid equations for the singular region of low-n modes. Later work will treat high-n ballooning modes. In addition, the ordering in the present work must be amended before it is applicable to the neighborhood of the field reversal surface of the RFP.

52371 (PPPL–2717) **Alpha particle destabilization of the toroidicity-induced Alfven eigenmodes.** Cheng, C.Z. Pacific Northwest Lab., Richland, WA (USA). Oct 1990. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE91000486. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The high frequency, low mode number toroidicity-induced Alfven eigenmodes (TAE) are shown to be driven unstable by the circulating and/or trapped α-particles through the wave-particle resonances. Satisfying the resonance condition requires that the α-particle birth speed $v_\alpha \geq v_A/2|m-nq|$, where v_A is the Alfven speed, m is the poloidal model number, and n is the toroidal mode number. To destabilize the TAE modes, the inverse Landau damping associated with the α-particle pressure gradient free energy must overcome the velocity space Landau damping due to both the α-particles and the core electrons and ions. The growth rate was studied analytically with a perturbative formula derived from the quadratic dispersion relation, and numerically with the aid of the NOVA-K code. Stability criteria in terms of the α-particle beta β_α, α-particle pressure gradient parameter (ω_*/ω_A) (ω_* is the α-particle diamagnetic drift frequency), and (v_α/v_A) parameters will be presented for TFTR, CIT, and ITER tokamaks. The volume averaged α-particle beta threshold for TAE instability also depends sensitively on the core electron and ion temperature. Typically the volume averaged α-particle beta threshold is in the order of 10^{-4}. Typical growth rates of the n=1 TAE mode can be in the order of $10^{-2}\omega_A$, where $\omega_A=v_A/qR$. Other types of global Alfven waves are stable in D-T tokamaks due to toroidal coupling effects.

52372 (PPPL–2718) **Partially linearized algorithms in gyrokinetic particle simulation.** Dimits, A.M.; Lee, W.W. Princeton Univ., NJ (USA). Plasma Physics Lab. Oct 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE91000492. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper, particle simulation algorithms with time-varying weights for the gyrokinetic Vlasov-Poisson system have been developed. The primary purpose is to use them for the removal of the selected nonlinearities in the simulation of gradient-driven microturbulence so that the relative importance of the various nonlinear effects can be assessed. It is hoped that the use of these procedures will result in a better understanding of the transport mechanisms and scaling in tokamaks. Another application of these algorithms is for the improvement of the numerical properties of the simulation plasma. For instance, implementations of such algorithms (1) enable us to suppress the intrinsic numerical noise in the simulation, and (2) also make it possible to regulate the weights of the fast-moving particles and, in turn, to eliminate the associated high frequency oscillations. Examples of their application to drift-type instabilities in slab geometry are given. We note that the work reported here represents the first successful use of the weighted algorithms in particle codes for the nonlinear simulation of plasmas.

52373 (PPPL–2721) **Weak turbulence theory of collisionless trapped electron driven drift instability in tokamaks.** Hahm, T.S.; Tang, W.M. Princeton Univ., NJ (USA). Plasma Physics Lab. Oct 1990. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE91000505. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The toroidal collisionless trapped electron modes are analyzed in the weak turbulence regime treating both ions and trapped electrons nonlinearly in the presence of ion and electron temperature gradients. The spectral intensity of the density fluctuations in the nonlinearly saturated state is analytically obtained from the steady state solution of the wave-kinetic equation. Distant nonlinear interactions between low-k_θ and high-k_θ modes of similar frequencies via trapped electron scattering (the resonance between the beat

wave and the trapped electron precession drift frequencies) suppress the low-k_φ [$k_\varphi \rho_s \ll (L_n/R)^{1/2}$] modes while close interactions via ion Compton scattering (nonlinear ion Landau damping) produce a monotonically decreasing spectrum from $k_\varphi \rho_s \cong (L_n/R)^{1/2}$ to $k_\varphi \rho_s \cong 1$ according to an approximate power law k_φ^{-3}. Various fluctuation amplitudes at saturation and the fluctuation-induced anomalous particle and heat fluxes are found to be smaller than the mixing length estimates. The plasma confinement is predicted to improve with higher T_i/T_e, more peaked density profile, larger aspect ratio, and higher plasma current. Also, a significant dependence of transport on the electron temperature gradient is found which could contribute to the rigidity of the electron temperature profile often experimentally observed.

52374 (PPPL–2722) **Burning plasmas.** Furth, H.P. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Goldston, R.J.; Zweben, S.J.; Sigmar, D.J. Princeton Univ., NJ (USA). Plasma Physics Lab. Oct 1990. 60p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE91000506. Source: NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The fraction of fusion-reaction energy that is released in energetic charged ions, such as the alpha particles of the D-T reaction, can be thermalized within the reacting plasma and used to maintain its temperature. This mechanism facilitates the achievement of very high energy-multiplication factors Q, but also raises a number of new issues of confinement physics. To ensure satisfactory reaction operation, three areas of energetic-ion interaction need to be addressed: single-ion transport in imperfectly symmetric magnetic fields or turbulent background plasmas; energetic-ion-driven (or stabilized) collective phenomena; and fusion-heat-driven collective phenomena. The first of these topics is already being explored in a number of tokamak experiments, and the second will begin to be addressed in the D-T-burning phase of TFTR and JET. Exploration of the third topic calls for high-Q operation, which is a goal of proposed next-generation plasma-burning projects. Planning for future experiments must take into consideration the full range of plasma-physics and engineering R&D areas that need to be addressed on the way to a fusion power demonstration.

52375 (PPPL–2723) **Observation of temperature dependent transport in TFTR.** Efthimion, P.C.; Mansfield, D.K.; Stratton, B.C.; Synakowski, E.; Bhattacharjee, A.; Biglari, H.; Diamond, P.H.; Goldston, R.J.; Hegna, C.C.; McCune, D.; Rewoldt, G.; Scott, S.; Tang, W.M.; Taylor, G.; Waltz, R.E.; Wieland, R.M.; Zarnstorff, M.C. Princeton Univ., NJ (USA). Plasma Physics Lab. Oct 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE91000504. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Local particle and heat transport coefficients have been measured in a controlled temperature scan of neutral-beam-heated plasmas with n, I_p, and B_φ held constant. The electron particle transport is ascertained from a general flux analysis of a small density perturbation, and the heat transport is obtained from the equilibrium power balance. The local particle and heat transport coefficients vary as T_e^α, where $\alpha = 1.5–2.5$. The observed temperature dependence for these plasmas is predicted by numerical calculations of anomalous transport due to trapped-particle drift-type microinstabilities.

52376 (TRITA-EPP–90-01) **Laboratory experiments on the magnetic field and neutral density limits on CIV interaction.** Axnaes, I.; Brenning, N. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics. Mar 1990. 41p. Order Number DE91602940. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Laboratory experiments are reported which determine the magnetic field and neutral density limit for Critical Ionization Velocity (CIV) interaction in the impact configuration. A combination of microwave interferometry and spectroscopy has been used to measure how the electron energy distribution varies with the neutral density and the magnetic field strength. The efficiency of the CIV process is evaluated in terms of the efficiency factor η of energy transfer to the electron. This efficiency is studied as function of the ratio V_A/V_0 between the Alfven velocity and the plasma stream velocity and the ratio ν_i/ω_{gi} between the ionization frequency and the ion gyro frequency. With other parameters kept constant, V_A/V_0 is proportional to the square root of the magnetic field, while ν_i/ω_{gi} is proportional to the neutral density. We have found that these two dimensionless parameters are coupled in such a fashion that a stronger magnetic field can compensate for a lower neutral density. For our strongest magnetic field, corresponding to $V_A/V_0 \approx 4$, CIV interaction is found to occur for a comparatively low value $\nu_i/\omega_{gi} \approx 0.1$. For $V_A/V_0 = 1$, we found a clear absence of CIV interaction even for ν_i/ω_{gi} approaching unity. (authors).

52377 Proceedings of the 6th topical conference on high temperature plasma diagnostics. 92p. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Topics covered in this book include: The TFTR Mirnov system, Spectra from a cooling/warming blackbody, and absorption spectroscopy of a laser produced plasma.

52378 Electron-excited molecules in nonequilibrium plasma. Proceedings of the Lebedev Physics institute, Academy of Sciences of the USSR. Volume 179, supplemental volume 2. Sobolev, N.N. 272p. Nova Science Publishers, Inc., Commack, NY (USA) (1989).

This book focuses on electron-excited molecules in nonequilibrium Plasma. Topics covered include: Distributions of electron-excited molecules over vibrational-rotational levels in gas discharge: Formation mechanisms; Electron-impact excitation levels of molecules electron states in gas discharge; and Doppler spectral line broadening and the velocity distributions of excited atoms and molecules in nonequilibrium plasma.

52379 Filtered x-ray diodes for imploding plasma experiments. Young, F.C. (Naval Research Lab., Washington, DC (USA)); Stephanakis, S.J.; Scherrer, V.E. pp. N19 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses imploding plasmas that provide intense sources of sub keV and keV x-rays for x-ray for x-ray laser experiments. X-ray diodes (XRD's) can be used to measure the power and energy of such radiation. XRD's with appropriate ulthrathin filters and selected cathode materials have been developed to measure specific spectral characteristics of x-rays from implosions driven by MA level currents on Gamble II. For Ar implosions, L-shell emission (0.2-0.46 keV) from Ne-like thru B-like ionization stages is measured with an Al-cathode XRD filtered with 0.7-μm Ti. For Ne implosions, emission of the single He-α line 0.92 keV has been measured with a Ni-cathode XRD filtered with 1.0-μm Cu, and a peak power of 50 GW has been observed. For Na, the He-α line at 1.13 keV is the pump for a Na/Ne matched-line photopumped x-ray laser. A Cu-cathode XRD filtered with 2.0-μm Ge can be used to measure this single line for Na implosions.

52380 Plasma density and poloidal field measurements on text using an injected lithium beam. West, W.P. (GA Technologies, Inc., Oak Ridge, TN (USA)). pp. I3 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses spectroscopy of an injected Li beam that has been used to determine both the plasma density profile and the poloidal field profile on the TEXT tokamak. The neutral Li beam is injected at energies up to 95 keV and both collisional and laser-induced fluorescence is observed during a tokamak shot. Radial and temporal profiles are obtained during a complete shot. The applicability of this technique to larger tokamaks depends on several parameters including (but not limited to) beam penetration, reliablity, spatial/temporal resolution, and signal-to-noise ratio. Because this basic technique obtains local measurements, it is also applicable to nonsymmetric devices. Such applications are discussed.

52381 Deconvolution of H-alpha profiles measured by Thompson scattering collecting optics. LeBlanc, B. (Princeton Univ., NJ (USA)); Grek, B. pp. J6 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses that optically fast multichannel Thomson scattering optics that can be used for H-alpha emission profile measurement. A technique based on the fact that a particular volume element of the overall field of view can be seen by many channels, depending on its location, is discussed. It is applied to measurement made on PDX with the vertically viewing TVTS collecting optics (56 channels). The authors found that for this case, about 28 Fourier modes are optimum to represent the spatial behavior of the plasma emissivity. The coefficients for these modes are obtained by doing a least-square-fit to the data subjet to certain constraints. The important constraints are non-negative emissivity, the assumed up and down symmetry and zero emissivity beyond the liners. H-alpha deconvolutions are presented for diverted and circular discharges.

52382 Ion temperatures and poloidal rotation in Alcator C plasmas. Benjamin, R.D. (Johns Hopkins Univ., Baltimore, MD (USA)); Moos, H.W.; Terry, J.L. pp. J5 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a high resolution, photon-counting detector, sensitive in the spectral region from 1200 Å to ~2000 Å, that has been mounted on the focal plane of a 1m Ebert-Fastie spectrometer for emission line shape studies. The detector is a microchannel plate based image intensifier which is fiber optically coupled to a linear self-scanning photodiode array. The resolving power of the spectrometer-detector system is ~5300 at 1200 Å and ~12,900 at 1800 Å. The results of the ion temperature studies, calculations of the Zeeman contribution to the measured line shapes and measured poloidal rotation velocities are presented.

52383 Magnetic field measurement based on Zeeman effect in charge exchange recombination excited lines. Wroblewski, D. (Johns Hopkins Univ., Baltimore, MD (USA)); Moos, H. pp. J9 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper suggests that the local magnetic field in a tokamak may be deduced from the analysis of polarization of light impurity ion lines excited by charge exchange recombination process. Profiles of visible lines of hydrogen-like carbon and oxygen are calculated with the use of a simple model which includes the fine structure, Doppler broadening and Zeeman effect. It is shown that, with appropriate polarization analyser and experiment geometry, the components of magnetic field, can be measured.

52384 The JET soft x-ray diode array diagnostic. Edwards, A.W. (JET Joint Undertaking, Abingdon (UK)); Gill, R.D.; Oord, E.; Fahrbach, H.U.; Weller, A.; Zasche, D.; Granetz, R.; Tsuji, I. pp. K5 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses that arrays of silicon diodes installed on Jet measure the plasma soft x-ray emission with high temporal and spatial resolution, allowing mhd effects to be investigated. The diagnostic consists of two pin-hole cameras which view the same toroidal cross-section in orthogonal directions.

52385 The TFTR vertical x-ray imaging system. Johnson, L.C. (Princeton Univ., NJ (USA)); Bitter, M.; Chouinard, R.; von Goeler, S.; Hill, K.W.; Liew, S.L.; McGuire, K.; Pare, V.; Sauthoff, N.R.; Young, K.M. pp. N2 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a vertically viewing x-ray imaging system, in conjunction with the existing 64-channel horizontal system on TFTR that permits two-dimensional tomography of soft x-ray emissivity, measurement of plasma (major) radial position, improved measurement of MHD phenomena and disruptions, and the possibility of measurement of Shafranov shifts, on a 10 μsec time scale. The compact, helium-filled x-ray camera employs four eight-channel silicon detector modules and views the plasma through a 3-mil thick beryllium window, providing 6 cm position resolution at the center. An x-ray absorber foil changer permits energy selection to match the horizontal XIS. Lead and hydrogenous shielding reduce noise from thermonuclear neutrons and associated gamma rays.

52386 Spectroscopic and interferometric measurements of laser-plasma produced blast waves. McClean, E.A. (Naval Research Lab., Washington, DC (USA)); Stamper, J.A.; Ali, A.W.; Ripin, B.H.; Manka, C.K.; Griem, H.R. pp. J11 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a laser-produced plasma that generates blast waves as it expands supersonically into a stationary photoionized background gas (N_2) at a pressure of 1-5 Torr. Using a combination of spectroscopic and interferometric measurements, time- and space- resolved values of the temperature and density are obtained. This study was performed with lasers energies of 20-120 J and pulse durations of ~5 nanoseconds. A 1-m spectrograph equipped with three photomultiplier channels; which are calibrated on an absolute scale is used for the spectroscopic measurements. The interferometry is done with a folded-wavefront interferometer. It uses an optical probe pulse that is split off of the main laser pulse, reduced in pulse duration (~300 ps), frequency-doubled to be in a convenient wavelength range, and time-delayed. Interferometric measurements can be made simultaneously with the spectroscopic measurements. Experimental data and the technique of analysis will be shown.

52387 High intensity lithium beam for Zeeman spectroscopy. Weber, P.G. (Los Alamos National Lab., NM (USA)); Masamune, S. pp. J10 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses how the Zeeman spectrum of neutral lithium introduced to hot plasma as a beam may be used to determine both the magnitude and direction of the local magnetic field. Dye lasers can improve the sensitivity either by intracavity absorption, or by resonance fluorescence. A limit of this diagnostic is set by lithium density in the plasma. A high density, 80 kV lithium beam has been developed for plasmas of larger dimension and/or higher densities, or to permit measurements with better time resolution than with previous beams. The beam utilizes a high density lithium ion source. Diagnostics include 2-D ion beam profiling, Faraday cup, magnetic analyzer and a pepperpot probe for measurements of beam intensity, composition and divergence. Beam currents can exceed 10 mA in a $\leq$2 cm diameter beam with a divergence of several mrad. Examples of parameter scans are presented.

52388 Radiaton diagnostics for x-ray laser experiments on Proto II. Spielman, R.B. (Sandia National Labs., Albuquerque, NM (USA)); Dukert, R.J.; Hammel, B.A.; Hanson, D.L.; Palmer, M.A. pp. N18 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses x-ray laser experiments on the Sandia Proto-II accelerator that use a wide array of radiation diagnostics. Precise x-ray measurements are difficult in the environment of a large pulsed power accelerator. Machine shock, EMP, and large x-ray fluences are significant problems. X-ray diodes and resistive

bolometers provide excellent time-resolved information. Crystal and grazing-incidence grating spectrographs and x-ray pinhole camera give time-integrated data. Using micro-channel plates or a scintillator and streak camera system to obtain time resolution are addressed. Precise alignment, nanosecond time resolution and high spectral precision are all needed for successful x-ray laser experiments. Descriptions of the diagnostics and data taken on recent x-ray laser experiments are presented.

52389 **SPRED spectrograph upgrade: High resolution grating and improved absolute calibration.** Stratton, B.C. (Princeton Univ., NJ (USA)); Bartolick, J.; Fonck, R.J.; Ida, K.; Jaehnig, K.P.; Ramsey, A.T. pp. J15 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses two improvements to the SPRED multichannel EUV spectrographs used on TFTR and PBX; A new 2100 g/mm grating covering the 100-320 Å0 region with 0.4 Å resolution (FWHM) has been added to the existing 450 g/mm grating (100-1100 Å with 2.0 Å resolution), and the TFTR SPRED has been absolutely calibrated using synchrotron radiation from the NBS SURF II facility and branching ratio measurements; the PBX system has been calibrated using branching ratios and line ratios from charge exchange recombination excited lines. The availability of high resolution spectra in the 100-320 Å range allows more reliable measurements of metallic ion emissions and, when the instrument views across a neutral beam as in PBX, provides a complete spectroscopic inventory of both low- and high-Z impurities in a single discharge.

52390 **High-yield direct drive experiments at Nova.** Lane, S.M. (Lawrence Livermore National Lab., CA (USA)); Cable, M.D.; Prussin, S.G.; Glendinning, S.G.; Munro, D.H.; Hatchett, S.P.; Estabrook, K.G.; Suter, L.J.; Richardson, M.C.; McKenty, P.W.; Roback, D.; Verdon, C.P. pp. K17 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a series of direct drive implosions of D-T filled, glass microballons initiated in an effort to produce intense neutron sources for diagnostics development. In particular, neutron sensitive streak camera, and fuel ρr by both neutron activation and neutron spectroscopy could be more easily tested with these simple targets than high density targets that initially are not expected to produce such high yields. Targets with nominal dimensions of 10000μm x 2μm which contained D-T at 12-14 atm were imploded with 18 kJ of 0.35μm light from the 10 beam NOVA system. For pulse widths of 1ns in either converging or diverging geometry, fusion yields in excess of 1013 have been obtained. The yields are comparable to those predicted from numerous 1d-model calculations in spite of the asymmetric illumination geometry of the driver.

52391 **Studies of subnanosecond x-ray switching and shuttering techniques.** Wark, J.S. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Hauer, A.; Kilkenny, J.D. pp. N16 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses experimental studies conducted of the changes in x-ray diffraction properties of crystals under intense subnanosecond laser heating. One beam of the PHOENIX laser system was used to create an intense source of x-ray line radiation. This radiation was in turn diffracted from a silicon crystal that was heated with the other beam of the laser. The diffracted radiation was temporally resolved with an x-ray streak camera. The diffracted lines are observed to broaden spectrally on a subnanosecond time scale. From the temporal structure of the diffrated radiation, information is derived on the nature of the laser heating process. Interruption of crystal diffraction on a subnanosecond time scale is potentially useful as mechanism for x-ray switching and shuttering. Considerations for the design and construction of such devices are discussed.

52392 **The TFTR diagnostic natural beam.** Schilling, G. (Princeton Univ., NJ (USA)); Kozub, T.A.; Medley, S.S.; Young, K.M. pp. K1 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a neutral beam designed and fabricated to aid in the measurement of ion temperatures of hot, dense TFTR plasmas. The injected fast neutral atoms have a twofold advantage: penetration to the plasma center considerably increases charge exchange neutralization of thermal plasma ions, leading to a localized enhancement of the thermal neutrals efflux into charge exchange neutral analyzers (CENA); and charge exchange recombination of intrinsic impurity ions, C or O, with fast neutral allows Doppler broadening and shift measurements of the emitted light (CHERS) to determine both the impurity ion temperature and toroidal rotation with unbalanced beam heating. Those features of the beam unique to its function as a diagnostic tool and initial measurements on TFTR are presented.

52393 **Measurement of 0.1-3 KeV x-rays from laser plasmas.** Kornblum, H.N. (Lawrence Livermore National Lab., CA (USA)); Kauffman, R.L.; Smith, J.A. pp. N24 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper describes absolute measurements of x-ray spectra made from 0.1-1.5 keV produced by plasmas from targets irradiated by the LLNL Nova laser. These measurements were made using a 15-channel K- and L-edge filtered x-ray diode system. Valid interpretation of the results from this type of diagnostic requires some care in eliminating the effect of channel response at photon energies higher than the absorption edge. Significant errors can occur if this is disregarded. The authors discuss the techniques used and the magnitude of the effects observed. Integrated x-ray energy in the 1.5-3 keV region is inferred from the results.

52394 **A large field, 200-psec gated microchannel plate detector.** Eckart, M.J. (Lawrence Livermore National Lab., CA (USA)); Hanks, R.L.; Kilkenny, J.D.; Pasha, R.A.; Wiedwald, J.D.; Hares, J.D. pp. J17 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a 15-mm-wide gated microchannel plate detector for uv and x-ray detection that has been built and tested. The detector is part of a 6-ohm transmission line driven by an electronically generated gating pulse. The microchannel plate is coated with CsI allowing tests with a frequency-quadrupled 1.05-μm laser. Results of tests using a high repetition rate, 4-ω laser show optical gate width down to 200 psec FWHM.

52395 **Spectral measurements from laser-produced plasma in OMEGA.** Burkhalter, P.G. (Naval Research Lab., Washington, DC (USA)); Newman, D.A.; Rosen, L.; Hudson, K.; Richardson, M.; Audebert, P. pp. N17 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses curved and flat-diffraction crystal spectrographs developed to collect x-ray spectra from high-atomic number elements (cadmium-rare earths) in the 5-19 Å region. The plasma source was generated by the 24-beam, frequency-tripled light of the OMEGA laser system. The spectral patterns for Cd, Sn, Ce and other rare earth elements were identified with the aid of atomic structure calculations to be predominately 3d-4p, 4f transitions over a range of ionization stages involving the M-shell.

52396 Diagnostic applications of the TFTR XIS system. McGuire, K. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Colchin, R.J.; Fredrickson, E.; Hill, K.; Johnson, L.C.; Sauthoff, N.; Von Goeler, S.; Pare, V. pp. N3 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the horizontal TFTR x-ray imaging system (XIS), an array of 64 silicon surface barrier x-rays diodes, with a 2.5 cm spatial resolution. The XIS system is primarily used to study MHD instabilities, but also been used to measure electron thermal diffusivity, impurity transport, electron temperature, the radius of the q = 1 surface, plasma vertical position and toroidal rotation of the plasma. Movable absorber foil arrays provide energy selection. Band-pass analog filters and digital techniques have been used on the x-ray signals in an attempt to infer turbulence levels in the plasmas. Details of these techniques are presented.

52397 Probes for edge plasma studies of TFTR. Manos, D.M. (Princeton Univ., NJ (USA)); Budny, R.V.; Kilpatrick, S.; Zweben, S. pp. L2 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses TFTR probes designed to study the interaction of the plasma with material surfaces such as the wall and limiters, and to study the transport of particles and energy between the core and edge. Present probe heads have evolved from prototypes in PLT, PDX (PBX), and the initial phase of TFTR operation. The newest heads are capacble of making several simultaneous measurements and include Langmuir probes, heat flux probes, magnetic coils, rotating calorimeter fast ion probes, sample exposure specimens. The authors describe these probe heads and presents some of the data they and their prototypes have acquired. They empphasize measurement of transient plasma during heating, compression, and free-expansion, and fluctuations in the edge plasma.

52398 X-ray spectroscopic methods for the diagnosis of laser imploded targets. Yaakobi, B. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Barnouin, O.; Richardson, M.C.; Sources, J.M.; Hauer, A. pp. M3 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses several methods involving x-ray spectroscopic methods for diagnosing laser-imploded targets. The first method involves the recording of absorption lines formed in the target tamper, out of the continuum emitted by a hotter compressed core. This method is applied to ablatively imploded targets having a thin KCL signature layer. The tamper $\rho\Delta R$ is deduced from the area within the absorption lines, whereas the tamper temperature is deduced from the intensity distribution among absorption lines of adjacent charge states. In second method, doubly diffracting crystals give two-dimensional monochromatic images of thin signature layers in spherical targets. Such information is useful in studying stability and mixing. Experimental results relevant to these methods will be shown and the limitations on their application to laser-target experiments are discussed.

52399 High energy x-ray microscopy with multilayer reflectors. Underwood, J.H. (Lawrence Livermore National Lab., CA (USA)). pp. M2 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper describes some of the recent progress in making and evaluating x-ray reflectors, and outlines the optical design considerations for multilayer-coated microscopes. Results from a prototype multilayer K-B microscope are presented.

52400 Simple models of pinhole closure in high-energy-density experiments. Harrach, R.J. (Lawrence Livermore National Lab., CA (USA)). pp. N32 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses analytical models describing the closure of diagnostic collimators and windows in high energy density experiments. The time-dependent transmission through an aperture of intense signals present in these experiments is controlled by the opacity of the ablation plasma produced by the signal itself. The author discusses self- similar hydrodynamic solutions applicable to the problem; theoretical models of opacity and equation-of-state for the warm plasma region (1-100 eV temperature, expanded-matter densities) of interest; comparison of the analytical model expressions for aperture transmission vs. time with the results of comprehensive one- and two-dimensional hydrocode calculations.

52401 Optical fiducials for x-ray streak cameras at LLE. Jaanimagi, P.A. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Gregory, G.G.; Hestdalen, C.; Kiikka, C.D.; Kotmel, R.; Richardson, M.C. pp. N30 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses how the incorporation of an optical timing fiducial onto a time-resolved x-ray streak record permits one to precisely relate the x-ray emission to the incident laser pulse. The authors approach to recording fiducials is twofold. In addition to recording the x-ray emission on a bifurated photocathode, they also streak the incident laser light at 351 nm which is scattered from the target and an independent signal at $4\omega_0$ (264 nm) which is derived by frequency quadrupling a tiny fraction of the OMEGA laser driver output. The signal at $4\omega_0$ is transported through the vacuum wall to the streak camera photocathode via fiber optics. A 200 Å aluminum layer on mica is utilized for the UF sensitive photocathode. Examples and further details of this system are presented.

52402 Green light (2ω) as an x-ray streak camera fiducial. Nilson, D.G. (Lawrence Livermore National Lab., CA (USA)); MacGowan, B.J. pp. N28 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the fiducial system for the multiple optical and x-ray streak cameras on the two Nova target chambers intended to allow cross comparison of time resolved data from laser plasmas to an accuracy of ± 50 psec. Development of the system has led to the discovery that Al coated fiber optics incorporated into the x-ray photocathode can be made to produce photoelectrons when irradiated by ~ 1 μJ of 2 ω light. The low loss and dispersion of 2 ω light in fused silica fibers are significant advantages over our original intention of using 3 ω light. Results indicating input and output pulse lengths and required energies to produce photoelectrons are discussed.

52403 Resolution characteristics of Lawrence Livermore National Laboratory soft x-ray streak cameras. Glendinning, S.G. (Lawrence Livermore National Lab., CA (USA)); Medecki, H. pp. N27 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses x-ray streak cameras characterized for spatial resolution and for the line spread function contribution to the temporal resolution. The contrast transfer function of a gold resolution grid of varying spatial frequency was measured for each camera. In addition, the image intensifier tube normally used for LLNL streak cameras was characterized separately. Limiting visual

resolution for the system was found at 10 1p/mm at camera photocathode with a corresponding temporal line spread function of 440μm FWHM. Limiting visual resolution for the intensifier was found at 14 1p/mm at intensifier photocathode. Comparisons to commercial streak camera models are described.

52404 Development of an x-ray framing camera. Stearns, D.G.; Wiednald, J.D.; Cook, W.M.; Hanks, R.L. pp. N26 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses an ultrafast x-ray framing camera being developed to be used as a diagnostic instrument in laser experiments. The framing camera is designed to provide temporal resolution of 50 ps and spatial resolution of 30 microns at the large plane. The unique design incorporates the x-ray photocathode directly into a suspended-strip transmission line. The photocathode is gated using a high-voltage (5 KV) pulse of short duration generated with a photoconductive switch. The photoelectrons are extracted through an unbiased microchannel plate and are directly detected with a CCD in the electron-bombardment mode. The authors report on current progress in the fabrication, characterization and integration of the various components of the instrument.

52405 Asymmetry of Stark-broadened Layman lines from laser-produced plasmas. Joyce, R.F. (Florida State Univ., Tallahassee, FL (USA). Dept. of Physics); Woltz, L.A.; Hooper, C.F. Jr. pp. N20 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses three significant causes of spectral line asymmetry: the ion-quadrupole interaction, the quadratic Stark effect and fine structure splitting that are included in the calculation of Lyman line profiles emitted by highly-ionized hydrogenic radiators in a dense, hot plasma. The line asymmetries are shown to be strongly dependent on the plasma density, indicating that the asymmetry may be of use as a density diagnostic.

52406 Escape factors for Stark-broadened line profiles. Mancini, R.C. (Florida State Univ., Tallahassee, FL (USA). Dept. of Physics); Joyce, R.F.; Hooper, C.F. Jr. pp. N21 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, New York, NY (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses escape factors for upper and lower limits to the source function appropriate for spherical geometry that have been evaluated using a set of Stark-broadened line profiles, computed with different approximations. The method used to compute the escape factors, which is based on a general formalism can be applied to any kind of line profile and is suitable for any geometry. The escape factor is expressed as an integral over the frequency of a functional of the line profile; hence our treatment highlights its dependence on the line profile. Comparisons are made with previous calculations that used Holtsmarkian line profiles and significant differences are noted.

52407 Absorption spectroscopy of a laser produced plasma. Kilkenny, J.D. (Lawrence Livermore National Lab., CA (USA)); Lee, R.W.; Kolbe, G.; Estabrook, K.; Landen, O.; Bailey, J. pp. N22 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses how pin plasma sources are used as x-ray backlights for an Al plasma produced by focusing 1.06 μm laser light to irradiances of 10^{12} W/cm^{-2}. Spatially resolved absorption features of the helium like states of ionization of the plasma allow ground state densities of the helium and hydrogen like stages to be measured. Comparison with simulations indicates the need for a realistic opacity effects to produce a high enough state of ionization for the plasma temperature.

52408 Effective γ x-ray excitation rates for plasma impurity measurements. Hill, K.W. (Princeton Univ., NJ (USA)); Bitter, M.; Von Goeler, S.; Hiroe, S.; Hulse, R.; Ramsey, A.T.; Sesnic, S.; Shimada, M.; Stratton, B.C. pp. N8 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses metal impurity concentrations measured by the pulse-height-analyzer diagnostic from Kα x-ray peak intensities by use of an averaged excitation rate $\langle\sigma v\rangle$. Low-z impurity concentrations are inferred from the continuum enhancement due to metals. Since the PHA does not resolve lines from different charge states, $\langle\sigma v\rangle$ is a weighted sum of rates; coronal equilibrium is usually assumed. Improved values of $\langle\sigma v\rangle$ using recent calculations for H-, He-, and Li-like Fe are 45% larger than the earlier rates and yield metal concentrations in better agreement with those from VUV spectroscopy. The effect of charge exchange with neutral hydrogen on coronal equilibrium and $\langle\sigma v\rangle$ is considered.

52409 Observations of centrally peaked impurity profiles in the Alcator-C tokamak following pellet injection. Petrasso, R.D. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Hopf, J.E.; Wenzel, K.W.; Sigmar, D.J.; Greenwald, M.; Terry, J.L. pp. N10 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses differently filtered x-ray arrays that have been used to instantaneously measure central carbon and molybdenum profiles, Alcator's dominant light and heavy impurities, following pellet injection. The width of the carbon profile is close to the neoclassical prediction of a source-free equilibrium state. The experimental molybdenum profile, which is more uncertain, is between a factor of 1.3 and 3.0 that of the asymptotic prediction of neoclassical theory. Carbon, the dominant non-hydrogenic contributor to Z_{eff}, is found to dramatically affect sawtooth dynamics by altering the central resistivity. Details of the instrumentation, as well as the plasma conditions needed to make such measurements, are described.

52410 Neutral hydrogen density and electron temperature measurements from Rydberg series of He-and H-like argon in the Alcator C tokamak. Rice, J.E. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Marmar, E.S.; Kallne, E.; Kallne, J. pp. N9 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the complete Rydberg series (1snp-1s^2 with $3 \leq n \leq 40$) of He-like argon (Ar^{16+}) has been observed with a compact, high resolution x-ray spectrometer at the Alcator C tokamak. Radial brightness profiles of the lines in the series have been obtained. In the plasma canter, the upper levels are populated by collisional excitation; in the outer regions, radiative recombination is the dominant population process for most of the lines. For the 1s9p- and 1s10p-1s^2 transitions at the plasma edge, charge transfer recombination between intrinsic neutral hydrogen and H-like Ar is the most important population mechanism. From known charge exchange cross-sections, the H_0 density profile can be obtained. Deduced profiles are in good agreement with those calculated from a neutral transport code. Line ratios of certain transitions in H- and He-like Ar are quite sensitive to the electron temperature. Time histories of T_e have been determined under a wide range of operating conditions.

52411 Spectra from a cooling/warming blackbody. Zahrt, J.D. (Los Alamos National Lab., NM (USA)); Shirk, D.G. pp. K14 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical

conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the investigation of the effects of thermal transients on the recorded spectrum of a blackbody source. The authors assumed that the response time of the detector is long compared to the time rate of change of the blackbody temperature. While the source is cooling/warming, it always emits as a blackbody at the instantaneous temperature. Several temperature-time models have been studied. The results are expressed in terms of the exponential integral and other related functions. In particular, for a source starting at temperature Θ and cooling linearly, the spectra is narrower (FWHM) and shifted to lower energy than a blackbody spectrum at temperature Θ. The results of this experiment show that it is possible to generate a non-Planckian shaped spectrum from a thermally evolving Planckian source.

52412 Initial comparison of TFTR neutral species measurements. Kugel, H.W. (Princeton Univ., NJ (USA)); Eubank, H.P.; Gammel, G.; Grisham, L.R.; Kaita, R.; Kamperschroer, J.H.; Kozub, T.A.; Medley, S.S.; O'Connor, T.; Prichard, B.; Langley, R. pp. K3 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract AC02-76CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses accurate measurements of neutral beam species fractions used for maximizing the neutral beam full energy component and for detail analysis of beam heated reactor grade plasmas. TFTR hydrogen and deuterium neutral beam species were measured using five complementary techniques. Optical Multichannel Analysis and D-D Reaction Analysis measurements were performed in the beamline neutralization region near the ion source. Optical multichannel Analysis, Charge Exchange Analysis. Rutherford Backscatter Analysis, and Neutral Beam Implantation/SIMS were used to study the output neutral beam. Initial results were obtained for four short pulse ion sources with different mechanical, gas feed, and electrical configurations. In general, the preliminary measurements are in agreement for similar operating conditions, but significant relative variations in species yields were observed for some ion source configurations and operating conditions. In addition, preliminary, species radial profile, species angular divergence, species kinetic energy spread, and beam impurity results were obtained.

52413 Neutral beam interlock system on TFTR using infrared pyrometry. Medley, S.S. (Princeton Univ., NJ (USA)); Kugel, H.W.; Kozub, T.A.; Lowrance, J.L.; Mastrocola, V.; Renda, G.; Young, K.M. pp. K2 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discuss how although the region of the TFTR vacuum vessel wall which is susceptible to damage by neutral beam strike is armored with a mosaic of TiC clad POCO graphite tiles, at power deposition levels above 2.5 kW/cm^2 the armor surface temperature exceeds 1200°C within 250 ms and itself becomes susceptible to damage. In order to protect the wall armor, a neutral beam interlock system based on infrared pyrometry measurement of the armor surface temperature was installed on TFTR. For each beamline, a three-fiber optic telescope views three areas of ~30 cm diameter centered on the armor hot spots for the three the ion sources. Each signal is fiber-optic coupled to a remote 1-μ pyrometer which feeds analog signals to the neutral beam interrupt circuits. The pyrometer interlock system is designed to interrupt each of the twelve ion sources independently within 10 ms of the temperature exceeding a threshold settable in the range of 500-1800C. A description of the pyrometer interlock system and its performance is presented.

52414 Vertical high resolution Bragg x-ray spectrometer for the Tokamak fusion test reactor. Bitter, M.; Hill, K.W.; von Goeler, S.; Johnson, L.C.; Raftopoulos, S.; Reale, M.; Schechtman, N.; Sesnic, S.; Spinos, F.; Pinter, G. pp. N6 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 12 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a Bragg x-ray spectrometer of high spectral resolution which accommodates three crystals and position sensitive detectors in the Johnann configuration and installed in the Tokamak Fusion Test Reactor (TFTR) diagnostic basement for the measurement of radial ion temperature profiles.

52415 Neutral-beam performance analysis using a CCD camera. Hill, D.N. (Lawrence Livermore National Lab., CA (USA)); Pincosy, P.A.; Allen, S.L. pp. K4 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses development of a diagnostic technique to measure (independent of the species mix of accelerated ions) the spatial distribution and absolute magnitude of the atomic-deuterium current produced by a natural-beam source. Using an absolutely calibrated CCD (charge-coupled device) video camera, the authors view the natural beam as it passes through a relatively high pressure (10^{-5} Torr) region outside the neutralizer: collisional excitation of the energetic neutrals produces a Dα emission (6561 Å) that is proportional to the local atomic current density. For the energy range of interest (5 keV>E>20 keV), the excitation rate coefficient is nearly constant to obtain the local atomic current regardless of the fraction of full, half, and third energy components. Digital processing of the video signal provides profile and aiming information for beam optimization. Results are compared with those obtained from a Faraday cup and infrared imaging of the beam dump.

52416 Space and time resolving spectrograph for fusion plasma diagnostics. Content, D. (Johns Hopkins Univ., Baltimore, MD (USA)); Wroblewski, D.; Perry, M.; Moos, H.W. pp. J14 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses construction of an EUV (60-350 Å) space and time resolving, grazing incidence spectrograph (STRS). The simultaneous spectral coverage of the instrument ranges from 20 to 60 Å, depending on the wavelength region. The spectral resolution is about 1 Å. The spectral resolution, accomplished by using the pinhole camera effect and the inherent astigmatism of a concave grating in grazing incidence, is about 2 m, with a total field of view of 60 cm at a distance of 2 cm from the plasma. The detector consists of a 75 mm MCP image intensifier optically coupled to three CCD area array detectors. Time resolution of up to 2 ms is achieved with high speed read-out electronics. A PDP 11.73 minicomputer controls the spectrograph and collects and reduces 3.0 MB of data per shot. The complete design of the STRS and the results of initial tests of the detector system, spectrograph, and data handling software are presented.

52417 Time resolved spectra in the 80-330 A wavelength region from PLT tokamak plasmas. Dave, J.H. (Naval Research Lab., Washington, DC (USA)); Feldman, U.; Seely, J.F.; Wouters, A.; Hinnov, E.; Suckewer, S. pp. J16 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses time resolved spectra from the PLT plasma recorded by the 2 meter Schwob-Fraenkel Spectrometer. In order to record the 80-330 Å wavelength range, the multichannel plate was moved several times. Spectra were recorded every 50 ms for the duration of the discharge. The data obtained were corrected so that distortions introduced by the flat rather than curved surface of the multichannel plate were accounted for. Examples of typical PLT spectra were wavelength accuracy of 0.02 Å will be shown. The spectra contain primarily ground state transitions in the ions of C, O, Cr, Fe and Ni. The observed lines are emitted typically from plasmas of 100-2000 eV. Examples of spectra of trace elements injected into the plasma during the discharge will also be shown.

These spectra are the result of subtraction of the signals after and before the injections.

52418 **Operation of multi-channel tangential bolometer on PBX.** Paul, S.F. (Princeton Univ., NJ (USA)); Fonck, R.J.; Schmidt, G.L. pp. K7 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses compact 15-channel bolometer array that views plasma emission tangentially across the mid-plane that has been installed on the PBX tokamak. By comparing these diagnostics, poloidal asymmetries in the emission profile can be determined. The detector array consists of 15 discrete 2 mm diameter thinistors, a sintered metal-oxide, which has a high temperature coefficient. Each active detector is operated in tandem with an identical blind detector in a constant current DC Wheatstone bridge configuration. The variation in bias voltage is amplified and stored on a CAMAC transient recorder. The detectors are sensitive to accumulated heat and software has been written to smooth and differentiate the signals so that instantaneous power can be calculated. The cooling time constants are determined (3.1 seconds) so that the loss of heat from the detector during the course of a shot can be compensated. The detectors were relatively calibrated with a tungsten-halogen filament lamp and were found be vary by ±7%. The irradiance profiles are inverted, and the emissivity is typically in the 0.1 to 0.5 W/cm^3 range.

52419 **Slitless intensified readout gated spectrometer.** Gerassimenlo, M. (Lawrence Livermore National Lab., CA (USA)). pp. J18 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses spectrometer developed to meet the requirements of the x-ray laser effort at LLNL. The instrument takes advantage of the instrinsically small divergence and size of the lasing source by putting it, and the grating and the detector on the Rowland circle. This design obviates the need for a slit but makes the target chamber an intergral part of the spectrometer. Sensitivity is maximized by intercepting the entire laser footprint, by keeping the angle of incidence upon the grating at about 70° to the normal and by single photon detection capability at the detector plane. Signal to background is greatly improved by gating the spectrometer at the sub-nanosecond level using three striplines structures deposited on the microchannel plate detector. The sum of incident and refracted angles is kept constant. By using simple spacers and custom ruled gratings any energy in the 60-200 eV range is accessible. Calibration and performance data are presented.

52420 **Nova experimental facility.** Campbell, E.M. (Lawrence Livermore National Lab., CA (USA)); Hunt, J.T.; Bliss, E.S.; Speck, D.R.; Drake, R.P. pp. L1 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the goals of the Nova laser facility to address critical issues for evaluating the feasibility of inertial confinement fusion, to implode DT to densities exceeding 200 g/cm^3 and pressures greater than 10^{12} atmospheres and to perform a wide range of high energy density plasma physics experiments in the areas of UVX/x-ray lasers, hydrodynamics, and radiation generation and transport. An extremely flexible and sophisticated facility is required to successfully perform such a variety of tasks. The facility has been designed to allow nearly simultaneous, independent experiments to be conducted in both target areas. A number of sophisticated optical, XUV, x-ray, and particle diagnostics measure target areas. An optical fiducial system allows cross-correlation of all of the diagnostic systems to better the 50 psec. An overview of the facility, diagnostics, and data acquisition system is discussed.

52421 **Development of gyrotrons for plasma diagnostics.** Woskoboinikow, P. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center). pp. L3 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses achievements in gyrotron technology that have created possibilities for new and improved millimeter and submillimeter-wave plasma diagnostics. This achievements are listed. Diagnostics which could benefit include: scattering diagnostics for the study of localized plasma waves, instabilities and turbulence, density interferometry, Faraday rotation polarimetry, and electron cyclotron emission and absorption heterodyne diagnostics. In particular, new diagnostics such as plasma imaging in three dimensions with many detector (⩾10) microbolometer or heterodyne arrays, and scattering from the ion thermal feature to determine localized ion temperature, magnetic field direction, or D/T fuel ratio may become practical with gyrotron sources. A 70 GHz gyrotron has been used for density fluctuation studies in the WT-2 tokamak at Kyoto. At M.I.T. we are implementing a 1kW, >30 ms pulsed, 137 GHz gyrotron scattering diagnostic on the TARA tandem mirror to study instabilities such as the drift cyclotron loss cone. This diagnostic is installed at the plug where, due to strong electron cyclotron resonance heating generated plasma noise, lower power klystron or EIO sources would not be practical.

52422 **Diagnostic system for measurement of particle balance in TMX-U.** Allen, S.L. (Lawrence Livermore National Lab., CA (USA)); Correll, D.L.; Hill, D.N.; Brown, M.D. pp. K5 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses several diagnostics that measure the particle sources and losses in the TMX-U plasma. An absolutely calibrated high-speed (0.5 ms per frame) filtered (6561 Å) video camera measures the total ionization source as a function of radius. An axial view of the plasma automatically integrates the axial variations within the depth of field of the system. Another camera, viewing the plasma radially, measures the axial source variations near the deuterium fueling source. Axial ion losses are measured by an array of Faraday cups that are equipped with grids for repelling electrons and are mounted at each end of the experiment. Nonequal ion and electron (nonambipolar) radial losses are inferred from net current measurements on an array of grounded plates at each end. Any differences between the measured particle losses and/or azimuthal asymmetries in the particle-loss profiles. Methods of system calibration, along with details of computer data acquisition and processing of this relatively large set of data are presented.

52423 **X-ray diagnostics for magnetic fusion.** Silver, E.H. (Lawrence Livermore National Lab., CA (USA)). pp. M1 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses research efforts in magnetic fusion which strongly depend upon information gained from x-ray observations of the confined plasma. Spectroscopic measurements make it possible to determine observations of the confined plasma. Spectroscopic measurements make it possible to determine plasma temperature, density, electron energy distribution, ionization state, impurity content, and plasma velocity. X-ray imaging provides estimates of the spatial distribution of a few of these parameters, facilities temporal studies of plasma size and shape, and indicates MHD activity. The author focuses on diagnosing tandem mirror plasmas. Detector requirements and limitations, recent instrument development and performance, and up to date x-ray measurements are discussed.

52424 **Fiber optic current sensor with Heterodyne detection.** Chandler, G.I. (Los Alamos National Lab., NM (USA)); Forman, P.R.; Jahoda, F.C.; Klare, K.A. pp. K13 of Proceedings of the 6th

topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the toroidal plasma current in the ZT-40M experiment (100-380 kA) measured using a fiber optic sensor. This sensor consists of six turns of permanently twisted, single mode fiber which was wound poloidally around the experiment. By modifying the laser output to a rotating linear polarization, amplitude independent single output heterodyne detection is possible. The signal is proportional to the B field produced by the plasma current so integration of the data is not required to obtain the current. Comparison with the existing Rogowski coil consistently shows less than 1% difference. Present efforts are directed toward simplifying the design to minimize optical alignment and to implement real time digital data reduction. The fiber current sensor has demonstrated accuracy comparable with existing techniques. It possesses broad frequency response, it eliminates insulation, electromagnetic interference, and ground loop problems and can easily be installed on existing plasma experiments.

52425 **An atmospheric arc facility to study the non LTE plasma properties of a magnetically rotated electric arc.** Frierson, R.V.; Eddy, T.L.; Putlko, V.F. pp. K16 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper describes a facility for the spectroscopic diagnostics of an electric arc in a rotating magnetic field. The magnetic field is used to convert the arc into a surface of revolution which internally provides a more uniform and controllable plasma for particle treatment or plasma chemistry applications. The magnetic field also enhances the spectral lines indicating a non-LTE condition. The facility resembles a wall stabilized chamber arc of 50 mm dia. having a tubular tungsten cathode (for injection) and a circular anode with a 20 cm gap. A motor stator surrounds the copper wall plates and is wound to provide a two pole rotating magnetic field. It was slotted to view the rotating arc. A high frequency, two phase amplifier and phase shifter are used to generate the rotating magnetic field in the coil. Present operating conditions are: 0-300 Gauss at 500-2000 hz and 100-1000 amps. The measurement of quasisteady and rotating arc temperatures is discussed.

52426 **Soft x-ray and visible imaging systems for measurement of noncircular tokamak plasmas in PHX.** Fonck, R.J. (Princeton Univ., NJ (USA)); Hulse, R.A.; Jaehnig, K.P.; Reusch, M; Roney, P. pp. J20 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

J20.

This paper discusses quantitative analysis of proximity-focused chevron microchannel plate images with the purpose of indirectly deriving information on the central plasma current distribution is presently underway, and two complimentary approaches being developed. The first directly inverts the toroidally projected image to obtain the poloidal emission distribution. The second maps the midplane emissivity distribution onto poloidal flux surfaces which are calculated by an MHD equilibrium code, and the generates a model image for comparison to the measured image. The data acquisition system has also been used to study emissions from the PBX divertor region as imaged through narrow band interference filters to isolate low charge states of H, C, and O.

52427 **An arc facility for investigating non-LTE thermodynamic and transport phenomena in low and high pressure plasmas.** Sedghinisab, A. (Georgia Inst. of Tech., Atlanta, GA (USA)); Eddy, T.L.; Murray, R.T. pp. K15 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a high pressure arc facility modified for computerized control and data acquisition to simplify measurements of non-LTE plasmas. The non-LTE methods have shown that numerous spectral lines and continuum must be accurately, precisely and quickly measured.The instrumentation uses a 1-m monochrometer with programmed wavelength slews and scans; oplasma scans; and monitoring of chamber pressure, current, voltages, and location. Multiple flows of various gases can be provided simultaneously. Plasma self absorption is determined via a concave back mirror and shutter with final alignment via computer plots. The raw data is corrected for absorption, zeroed, centered and smoothed. The net line intensity is then determined and Abeled prior to feeding into LTE or non-LTE analysis methods. Sample results are presented at 0.1,1 and 10 atm.

52428 **A novel scanning method for tokamak spectroscopy.** Ramsey, A.T. (Princeton Univ., NJ (USA)). pp. J4 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the problem of optical access for spectroscopic diagnostics to all poloidal regions of a plasma in a current generation tokamak which has become severe. Window sizes are limited and plasmas have grown; as a result, one must scan a large angle through a small window in a high (over 5 Tesla) field, often at elevated temperatures. No prudent person wants to put a moving system in such an environment. A system has been designed which uses only a mirror at the window. The rest of the elements (field lenses, a small, easily shielded mirror scanner, and the spectrometer) are several meters away behind a wall. The details of a design for TFTR are presented. All components are catalog items. Scan angles of $\pm 40°$ are achieved, and the scan angle in the plasma is linearly proportional to the ramp voltage applied to the scanner. Access to tokamak is through a 15 cm hole in the floor, and the optics of the spectrometer are filled.

52429 **Some non-LTE diagnostic methods for hydrogen plasmas.** Eddy, T.L. (GA Technologies, Inc., Oak Ridge, TN (USA)); Cho, K.Y. pp. J8 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 Grant CPE-8311325. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper shows that if electric and magnetic fields are not negligible, then the 2-T model assumed by many non-LTE plasma diagnostic techniques may lead to serious errors. Significant difference between T_e and T_{ex} have been shown to exist with electric field strengths as low as ~10 V/cm. Multithermal equilibrium (MTE) calculations show significant deviations in line emission coefficients when $T_e \neq T_{ex}$ compared to equivalent $T_e \neq T_q$. A quasi non-dimentional MTE continuum relation is present to assist in diagnostics. Normalized line emission coefficients verses N_e are used to indicate the type and extent of non-LTE. The MTE state diagram for hydrogen is used to show why non-LTE plasmas often appear to be in LTE based on N_e determinations.

52430 **The study of the detached plasma regime in TFTR using the MIRI far infrared interferometer.** Mansfield, D.K. (Princeton Univ., NJ (USA)); Park, H.K.; Strachan, J.D.; Bush, C.E.; Grek, B.; Johnson, D.W.; Johnson, L.C.; Stauffer, F.J.; Schivell, J. pp. H20 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses how plasmas have been formed in TFTR which separate completely from the limiter and are called detached plasmas. The physical evidence for the separation from the limiter is that all the ohmic input power is radiated away at the plasma boundary which can be 10→30 cm inside the limiter. The 10 chord multichannel MIRI interferometer system has been used to diagnose this region and follows the formation of the detached state through a MARFE. MIRI indicates that a plasma ~0.5→1 x 10^{13}

cm^{-3} occurs in the region between the luminous boundary and the limiter.

52431 Multichordal charge exchange recombination spectroscopy on the D3-D tokamak. Seraydarian, R.P. (GA Technologies, Inc., Oak Ridge, TN (USA)); Burrell, K.H. pp. J2 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses significant improvements in the spectroscopic system to measure ion temperature and plasma rotation speed profiles on D3-D. The number of spatial chords increase from six tangential chords viewing one neutral beam to eight tangential and eight vertical chords viewing separate neutral beams. These views allow measurement of both toroidal and poloidal rotation. Instrumental response improves by coupling the two spectrometers to the tokamak using one, 1.5 mm diameter quartz fiber per chord, thus solving the spectral alignment problem associated with use of three, 600μ fibers per chord. By increasing photon gain through use of a two stage image intensifier, minimum time resolution of 2 ms is possible. Enhanced memory in the data acquisition system allows up to 256 consecutive spectra to be acquired per shot. Unique features of the alignment and calibration procedures are discussed.

52432 CHERS: Charge exchange recombination spectrometer for ion temperature measurement on TFTR. Jaehnig, K.P. (Princeton Univ., NJ (USA)); Fonck, R.J.; Arnold, N.; Lagin, R.; Kindsfather, R.; Schneider, U. pp. J1 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract AC02-76CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses spatially and spectrally imagining spectrometer system being prepared for installation on TFTR and principally used to provide ion temperature and rotation velocity profiles via charge exchange recombination spectroscopy. High speed (8 MHz) 10-bit digitization and buffering of raw data is described. The entire system is controlled by a dedicated micro-VAXII microcomputer which provides both real-time control of the image processor during a discharge and standard CAMAC-driven control functions. Data normalization, compression, and line fitting is performed with both a high-speed pipeline processor and the micro-VAXII CPU. The generic detector and data acquisition hardware and software have been tested with an equivalent LSI-11/73 driven system on PBX.

52433 Flat response detectors from UV and x-ray region. Kania, D.R. (Los Alamos National Lab., NM (USA)). pp. I2 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper studies millimeter cubes of InP doped with Fe and neutron damaged GaAs for use as detectors in the UV and X-ray region. The results of measurements are reviewed and the limits of the applicability of these detectors are described.

52434 Spectroscopic diagnostics of a copper laser-produced plasma produced by a line focus on a thin target. Lee, T.N. (Naval Research Lab., Washington, DC (USA)); Moland, F.P.; Elton, R.C. pp. J19 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses 500J 2-6 ns Nd-laser focused to a 12 mm x 100 μm line on a thin (400-1500 Å) copper coating, supported by a 1500 Å thick formvar substrate. Space-resolved 8-13 Å x-ray spectroscopy and pinhole photography have been utilized. The main spectral features typically observed include intense neon-like Cu XX lines and somewhat less-intense Cu XIX and XXI lines. Two types of axial structure are observed: one is characterized by a finely (<100 $\mu\pi$ corrugated irregular structure, and the other by a mm-scale non-uniformity. The former could well be due to an early development of a hydrodynamic instability, while the latter appears to be associated with a mismatch between the laser pulse risetime and a characteristic (thickness-dependent) foil vaporization time. The electron temperature of the Cu XX plasma has been estimated from line intensity ratios of the nd-2p ($n \geq 4$) transition lines.

52435 Analysis of highly asymmetric radiation loss profiles in TFTR. Schivell, J. (Princeton Univ., NJ (USA)); Bush, C.E. pp. K9 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract AC02-76CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the profiles measured in TFTR with two bolometer arrays, one of which looks in at the plasma horizontally and one vertically. Under some conditions the profiles have large, poloidally local features. The most common are marfes and the enhancement from running the plasma on the inner bumper limiter. It turns out that marfe behavior shows up very clearly in the bolometer arrays. The profiles have been analyzed by separating the marfe radiated power from the normal part of the plasma. Marfe location is determined by inspection. It shows an evolution from stationary to moving marfe to detachment from the limiter. Marfe power is a sensitive function of plasma density. For a given level of marfe power the threshold density is a function of q which behaves much like the density limit. For the inner bumper profiles a 2-D reconstruction procedure has been developed, dividing the cross-section into zones which are tailored to the authors' specific geometry.

52436 A system for laser injection of tracer elements into TFTR plasmas. Timberlake, J. (Princeton Univ., NJ (USA)); Cohen, S.; Dereka, N,; Luyer, S. pp. K10 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses a vacuum and manipulator system built for a TFTR experiment which utilizes the laser blow-off technique to inject various elements into TFTR plasmas for diagnostic purposes. Large (17 in) square pyroflat flanges are used for improved access. Internal target positioning is provided by two perpendicular pairs of rotary motion feedthroughs connected to threaded, electropolished stainless steel rods with SP-3 polyimide nuts. This combination has provided low friction properties in-vacuo in off-tokamak tests. The configuration of the target manipulator is such that equal gravitational loading occurs on both the x- and y-drives. The entire system has been subjected to 0°-150°C thermal cycles and suffered no degradation in vacuum or mechanical properties.

52437 Optical and uv/x-ray imaging diagnostics for imploding foil experiments. Lee, P.H.Y. (Los Alamos National Lab., NM (USA)); Price, R.H.; Reay, J.; Pecos, J.; Seagrave, J.; McGurn, J.; Cochrane, B.; Anderson, B. pp. J21 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

In this paper, the authors use a framing camera consisting of 4 gated microchannel plates with adjustable gate and interframe times to record optical or uv/x-ray emission images during the implosion of inductively driven ultra-thin cylindrical foils. Since the flux compression generator and the opening switch are driven by high explosives, the framing camera is located at a distance from the experiment. For optical imaging in the visible region, an f/10, 2800 mm focal length catadioptric telescope is used to image the foil into the microchannel plates. For uv/x-ray imaging, we mount a disposable pinhole camera on the target chamber with a P-Terphenyl-coated screen to convert the uv/x-ray image into the visible region, the same optical imaging procedure is then used. This instrument is well suited for recording a sequence of events where the brightness changes by many orders of magnitude.

52438 Photoconductor x-ray detectors and bolometers. Wang, C.L. (Lawrence Livermore National Lab., CA (USA)); Auerbach, J.M.; Eckels, J.D.; Kornblum, H.N.; Pocha, M.D.; Price, D.F.; Slaughter, D.R.; Smith, J.A.; Kania, D.R.; Wagner, R.S. pp. N25 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper reports tests of InP:Fe, GaAs, GaAs:Cr, and polycrystalline Si, at Nova laser with 1 ns low energy x-rays, at Febetrons with 3 and 30 ns 100 keV x-rays, at Zapp Z-pinch machine with 100 ns low energy x-rays and at the Lawrence Livermore National Laboratory electron linear accelerator with 50 ps 100 MeV γ-rays. The temporal and spectral responses are discussed.

52439 Radial and tangential scanning of the hard x-ray Bremsstrahlung emission from tokamak plasmas. Von Goeler, S. (Princeton Univ., NJ (USA)); Stevens, J.; Bernabei, S.; Bitter, M.; Chu, T.K.; Hill, K.W.; Hooke, W.; Hosea, J.; Hsuan, H.; Jobes, F. pp. NI of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the launching of RF waves in the lower-hybrid and electron-cyclotron range of frequencies which leads often to the formation of energetic non-Maxwellian tails of the electron velocity distribution. The electron velocity distribution is derived from the hard x-ray bremsstrahlung emission. It is measured by radial and tangential arrays of hard x-rays detectors, consisting of 3 in. x 3 in. NaI crystals. The detectors are operated either in the pulse height analysis mode to obtain photon spectra or in the current mode to record time variations with frequencies up to 10 kHz.

52440 Pyroelectric x-ray detectors and x-ray pyrometers. Wang, C.L. (Lawrence Livermore National Lab., CA (USA)); Auerbach, J.M.; Eckels, J.D.; Koo, J.C.; Kornblum, H.N.; Price, D.F.; Smith, J.A.; Stotlar, S.C. pp. N23 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses pyroelectric detectors which are very promising x-ray detectors for intense pulsed x-ray/γ-ray measurements and can be used as x-ray pyrometers. They are fast, passive, and inherently flat in spectral response for low energy x-rays. The authors report tests of $LiTaO_3$, $Sr_{.5}Ba_{.5}Nb_2O_6$ and $LiNbO_3$ detectors at Nova laser with 1 ns low energy x-rays and at Zapp Z-pinch machine with 100 ns x-rays. The temporal and spectral responses are discussed.

52441 Evaluation of soft x-ray average recombination coefficient and average charge for metallic impurities in beam heated plasmas. Sesnic, S.S. (Princeton Univ., NJ (USA)); Bitter, M.; Hill, K.W.; Hiroe, S.; Hulse, R.; Shimada, M.; Stratton, B.; Von Goeler, S. pp. N7 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses the soft x-ray continuum radiation in TFTR low density neutral beam discharges which can be much lower than its theoretical value obtained by assuming a corona equilibrium. This reduced continuum radiation is caused by an ionization equilibrium shift toward lower states, which strongly changes the value of the average recombination coefficient of metallic impurities γ, but only slightly the average charge Z. The authors demonstrate the parametric dependence of γ and Z for Ti, Cr, Fe, and Ni impurities on neutral density (equivalent to beam power), electron temperature and electron density. These values are obtained by using either a one-dimensional transport code (MIST) or a zero dimensional code with a finite particle confinement time. As an example, we show the variation of γ and Z in different TFTR discharges.

52442 Two-dimensional tokamak density distribution measurements using phase-imaging interferometry. Doyle, E.J. (California Univ., Berkeley, CA (USA)); Howard, J.; Peebles, W.A.; Luhmann, N.C. Jr. pp. H21 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors present two-dimensional tokamak density distribution measurements. These measurements have been made using phase-imaging interferometry.

52443 Toroidal variation of power radiated from TFTR. Bush, C.E. (Oak Ridge National Lab., Oak Ridge, TN (US)); Schevell, J.; Medley, S.S.; Ulrickson, M. pp. K8 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 DOE Contract AC02-76CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses bolometers located at a number of toroidal and poloidal positions and used to determine the toroidal distribution of impurity radiation losses from TFTR plasmas. Distributions for both OH and beam heated H^+, D^+ and He^{++} plasmas have been determined.The distributions are highly peaked at the limiter sector for plasmas run on the outer limiter but more symmetric toroidally when run on the inner bumper limiter. Plasmas detached from both inner and outer limiters have distributions which are basically symmetric toridally and poloidally. The widths of toroidally peaked distributions are $\approx$1 sector of the 20 sector torus. Toroidal distribution data along with limiter temperature data allow for a complete accounting of input power for a large number of TFTR discharges. Scalings of the enhanced radiative losses at the limiter with input power, n_e, and I_p have also been determined.

52444 Very high power density subpicosecond laser for x-ray laser development. Suckewer, S. (Princeton Univ., NJ (USA)). pp. 44 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

A KrF excimer laser system with a pulse duration of 300 fsec and peak power density of $\sim 10^{18}$ W/cm^2 is presented. Use of this system for the excitation and ionization of a laser produced, magnetically confined plasma used in the development of a new x-ray laser is discussed.

52445 Physical processes in femtosecond laser-target interactions. More, R.M. (Lawrence Livermore National Lab., CA (USA)). pp. 67 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The authors review nonequilibrium atomic, electrodynamic, and radiative processes in short pulse plasma generation. They identify which are most important and which pose the most interesting questions.

52446 Ultrashort pulse laser heating of solids. Falcone, R.W. (California Univ., Berkeley, CA (USA). Dept. of Physics); Murnare, M.M.; Kepteyn, H.C. pp. 68 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324–: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

Ultrashort pulse lasers have been used to heat solid and near solid density plasmas to several hundred volt electron temperatures. The relevant absorption mechanisms and the behavior of material in these conditions are discussed.

52447 Direct measurement of the duration of subpicosecond soft x-ray pulse. Van Woerkom, L.D. (AT and T Bell Labs., Murray Hill, NJ (USA)); Freeman, R.R.; Davey, S.; Cooke, W.E.; McIlrath, T.J. pp. 83 of High energy density physics with

subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The authors have measured, with 100 fsec resolution, the subpicosecond pulse duration of a soft-xray pulse produced from a laser plasma driven by a high intensity, 300 fsec 308 nm laser. The technique employs the cross correlation of a 100 fsec 616 nm laser pulse with the x-ray pulse in high density krypton. The 616 nm laser pulse effectively switches the absorption of the x-rays in the krypton off and on with a resolution exactly equal to its pulse duration.

52448 Comparison of multiphoton and collisional ionization in high intensity laser-plasma interactions. Meyerhofer, D.D. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Augst, S.; Chuang, Y.H.; Delettrez, J.; Richardson, M.C. pp. 46 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

Recent multiphoton ionization experiments, have shown that the tunneling ionization theories for complex atoms of Ammosov, et al. are valid in the regime where $n^* > 2$ and the Keldysh tunneling parameter, γ, is less than 1. $n^* = Z\,(E_h/E_{ion})^{0.5}$ with E_h the ionization potential of hydrogen, and E_{ion} that of the charge state of interest. $\gamma = (E_{ion}/2\Phi_{pond})^{0.5}$ where Φ_{pond} is the pondermotive potential of the laser. In high intensity laser-plasma and laser-solid interaction, tunneling ionization due to the laser field may become a dominant ionization channel. The authors discuss the laser and plasma characteristics required for multiphoton ionization to become the dominant ionization process and the effects this has on high intensity, laser-plasma and laser-solid interactions.

52449 The dynamics of dense plasmas produced by ultra-short pulse lasers. Umstadter, D. (AT and T Bell Labs., Murray Hill, NJ (USA)); Freeman, R.R.; Milchberg, H.; McIlrath, T. pp. 89 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The interaction of an ultra-short pulse high intensity laser with a solid target is of current interest because the resulting plasma is also solid density. Such a plasma might be a bright short pulse continuum x-ray source to pump an x-ray laser or probe transient properties such as phase transitions or biological phenomena. Recent experiments have revealed that these plasmas are good continuum emitters and that the continuum x-ray duration is subpicosecond (streak camera limited). The x-ray pulse width is primarily determined by the rate at which the electrons and the ionization stages cool from the diffusion of heat into the solid and the expansion of material into the vacuum. The authors report the results of a one dimensional fluid code that models the interaction of an ultra-short laser pulse with a solid target of Aluminum. They describe the dynamics of the mass density, pressure, ionization and expansion velocity.

52450 Ultra-high intensity lasers and experiments at Los Alamos. Schappert, G.T. (Los Alamos National Lab., NM (USA)); Casperson, D.E.; Cobble, J.A.; Jones, L.A.; Kylala, G.A.; Lee, P.H.Y.; Nichols, T.D.; Taylor, A.J.; Tallman, C.R. pp. 35 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

Recent development in excimer laser technology have made it possible to achieve irradiances on target approaching 10^{20} W/cm^2. Oscillators capable of generating subpicosecond pulses and amplifiers capable of amplifying these pulses without significant pulse stretching or optical distortion are now available. Hence ultrashort pulses of modest energies, focused to nearly-diffraction-limited spots a few microns in diameter, result in an irradiance in excess of 10^{19} W/cm^2. Such laser systems typically operate at a repetition rate of several Hz, ideal for experimental programs. This paper reports on two laser facilities, a KrF and a XeCl system, capable of greater than 10^{17} and 10^{19} Watts/cm^2 respectively.

52451 High intensity picosecond pulse interaction experiments. Richardson, M.C. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Chen, H.; Chuang, Y.H.; Delettrez, J.; Epstein, R.; Kessler, T.; Meyerhofer, D.D.; Uchida, S.; Yaakobi, B. pp. 2 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The development of intense short pulse ($\lesssim$ 1ps) laser radiation focusable to extremely high intensities makes possible the investigation of many new regimes in atomic, plasma and nuclear physics. This paper reports on a high power Nd:glass laser system based on chirped pulse amplification which is being assembled for a variety of interaction experiments at focused intensities of up to 10^{18} W/cm^2. Plans are underway to generate even higher intensities with a second laser system having an output energy in the 100 J range, which will also be used to study short-wavelength x-ray laser schemes. Initial interaction experiments at intensities of $\lesssim$ 10^{16} W/cm^2 have concentrated on characterizing energy coupling and x-ray generation with a range of plasma and x-ray diagnostics. These are made concurrent with the development of analytical and numerical models of the interaction mechanisms, atomic physics and hydrodynamics involved in these plasmas. Under prevailing focus spot irradiation conditions on planar solid targets of various materials, efficient coupling (<50%) to a short scale-length plasma is observed, with the creation of highly ionized states, as characterized by x-ray and XUV spectroscopy.

52452 An accelerating reference frame for electromagnetic waves in a rapidly growing plasma: Unruh radiation and the dynamic Casimir effect. Yablonovitch, E. (Bellcore, Navesink Research Center, Red Bank, NJ (US)). pp. 7 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

In 1974, Hawking showed that black holes can evaporate by the emission of low temperature thermal radiation, now named Hawking radiation. Shortly thereafter, a closely related effect called Unruh radiation became apparent. The author discusses how, according to Unruh and Davies, observers of the electromagnetic field in an accelerating reference frame should see thermal radiation at a temperature T: $KT = h/2\pi\ a/c$ where a is the acceleration relative to an inertial frame, c is the speed of light and h and K are Planck's and Boltzmann's constant respectively. In a frame accelerating at g = 980 cm/sec^2, equivalent to the acceleration experienced at the earth's surface, this thermal radiation is at a temperature of only 4×10^{-20} °K. Therefore, physicists hoping to observe this radiation, have sought out systems being subjected to extreme acceleration.

52453 The interaction of intense laser pulses in plasmas. Prangle, P. (Naval Research Lab., Washington, DC (USA). Plasma Physics Div.); Esarey, E.; Ting, A. pp. 4 of High energy density physics with subpicosecond laser pulses. 1989 technical digest series: Volume 17. Optical Society of America, Washington, DC (USA) (1989). pp. 105 (CONF-8909324--: High energy density physics with subpicosecond laser pulses, Snowbird, UT (USA), 11-13 Sep 1989).

The interaction of ultra-high power laser beams with plasmas is rich in a variety of wave-particle phenomena. These phenomena become particularly interesting and involved when the laser power is high enough to cause the electron oscillation velocity to become highly relativistic. Some of the laser-plasma processes discussed include the production of large amplitude plasma waves which could be used to accelerate electrons to ultra-high energies; the possibility of modifying the plasma refractive properties in order to achieve optical guiding of a laser pulse, thus preventing the laser pulse from diffracting; and the possibility of producing coherent radiation at harmonics of the incident laser frequency.

52454 Ion temperature profile measurements using the far line wings of H_α. Bengtson, R.D. (Texas Univ., Austin, TX (USA)); Boedo, J.; Rowan, W.L. pp. 57 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper presents ion temperature profiles for the outer half of the TEXT plasma using the Doppler broadened far line wings of the H_α line profile. The technique depends on the assumption that the hydrogen neutrals have equilibrated with the ions through charge exchange collisions. Data reduction depends upon going far enough out on the line wing that the intensity profile is characteristic of the hottest portion of the plasma along the line of sight, thus removing the need for an inversion procedure. A Fabry-Perot interferometer is used to measure the line profiles because of its superior instrumental profile. This technique is compared with the charge exchange technique and Doppler broadening of impurities. The application to ion temperature measurements using a diagnostic neutral beam is also discussed.

52455 High-resolution Fourier transform spectroscopy: Line widths and line shapes of spectral lines emitted from helium and mixed-gas inductively coupled plasmas. Montaser, A. (Dept. of Chemistry, George Washington Univ., Washington, DC (US)); Ishii, I. pp. 509 of Proceedings of the 7th international conference on Fourier transform spectroscopy: Volume 1145. Cameron, D.G. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). pp. 642 (CONF-890674–: 7. international conference on Fourier transform spectroscopy, Fairfax, VA (USA), 19-23 Jun 1989).

Previous studies of line widths and shapes of spectral lines emitted from the inductively coupled plasmas (ICP) have concentrated on plasmas sustained in pure argon. For the present study, the authors used the Los Alamos Fourier transform spectrometer to estimate line widths and line shapes of Fe I lines emitted from helium and argon-nitrogen ICP discharges. The effect of gas composition and plasma operating conditions on widths and shapes of the spectral lines are examined. Line widths and line shapes of Fe lines are compared with those of argon and helium for Ar ICP and He ICP discharges. Results are used to calculate Doppler temperatures and electron numbers densities of the cited plasmas.

52456 Hot and cold fusion. *Compressed Air (USA),* 95(8): 18-25 (Aug 1990).

This article presents an overview of research in cold fusion research and development in cold fusion at the Tokomak Fusion Test Reactor at the Princeton Plasma Physics Lab, and at the inertial containment facility at Lawrence Livermore National Lab. is described.

52457 A review of recent results with Electron Cyclotron Heating in tokamaks. Prater, R. (General Atomics, San Diego, CA (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 22-31 (1 Jul 1989). DOE Contract AC03-89ER51114. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Many experiments using Electron Cyclotron Heating (ECH) of plasmas in tokamaks have been reported over the past two years. At a power level of 4 MW, ECH has achieved electron temperatures as high as 10 keV in the T-10 tokamak, and the H-mode has been attained in divertor discharges in DIII-D and JFT-2M. Regarding global energy confinement in either L-mode or H-mode, ECH appearch to be quite similar in efficiency to neutral injection, but in addition to bulk heating it has been useful for many purposes, including study of local electron heat diffusivity through pulses modulated heating; suppression of sawteeth, Edge Localized Modes, and other MHD activity; suppression of disruptions; preionization and startup; and current drive. In this paper, progress in these areas which has been reported since the IAEA meeting in 1986 will be summarized.

52458 Preparation for propagation and absorption experiments in MTX. Byers, J.A. (Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Cohen, R.H.; Fenstermacher, M.E.; Hooper, E.B.; Meassick, S.; Rognlien, T.D.; Smith, G.R.; Stallard, B.W. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 36-39 (1 Jul 1989). DOE Contract W-7405-ENG-48. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Preparatory calculations of microwave transmission through the MTX access duct, propagation of the waves through the plasma and the resulting power deposition profile on a calorimeter located on the tokamak inside wall have been performed. The microwave transmission calculations include the relative phase slippage of waveguide modes in the duct to determine the spatial structure of the wavefront at the duct exit. Ray-tracing calculations show substantial spreading of the beam in the poloidal direction at densities above 1.5×10^{20} m^{-3}, well within the range of the experiments. Initial experiments with low or high toroidal field (cyclotron resonance outside the plasma) will investigate both diffraction and refraction effects, without absorption. Estimates of the fractional absorption of the beam in the initial experiments with the cyclotron resonance at the plasma axis have also been made.

52459 Electron cyclotron current drive by radial transport of particles in a tokamak. Park, S. (Tokamak Fusion Laboratory, University of California, Los Angeles, CA (USA)); Taylor, R.J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 64-67 (1 Jul 1989). DOE Contract FG03-86ER53225. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Plasma currents have been generated by injecting microwaves at the electron cyclotron resonance frequencies to the Continuous Current Tokamak in the absence of any other power input. The radial profiles of plasma current and particle densities show that the current is driven by the radial flow of electrons acted upon by the self-consistent vertical magnetic fields in a way a dynamo acts. Also the energy spectrum of the current carrying electrons shows that the current is carried by the bulk of the plasma electrons and no superthermal electron contribution was detected.

52460 Electron cyclotron assisted startup and heating scenarios in the compact ignition tokamak. Porkolab, M. (Plasma Fusion Center, MIT, Cambridge, MA (USA)); Bonoli, P.T.; Englade, R.; Myer, R.C.; Smith, G.R.; Kritz, A.H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 68-71 (1 Jul 1989). (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Electron Cyclotron Radio Frequency heating of the Compact Ignition Tokamak to ignition utilizing a constant source frequency is proposed. The importance of varying the anomalous conductivity ratio is examined for high density discharges with parabolic density profiles. It is concluded that low to moderate values of the anomalous conductivity ratio are desirable for ignition at reasonable RF and alpha powers, with confinement times of the order of 0.6 sec. (AIP)

52461 Optimum launching of electron-cyclotron power for localized current drive in a hot tokamak. Smith, G.R. (Lawrence Livermore National Laboratory, University of California, Livermore, CA (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 80-83 (1 Jul 1989). DOE Contract W-7405-ENG-48. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Optimum launch parameters are determined for localized electron-cyclotron current drive near the magnetic axis and the q=2 surface by solving several minimization problems. For central current drive, equatorial and bottom launch are compared. Localized current drive near q=2 is studied for equatorial launch and for an alternative outside launch geometry that may be better for suppressing tearing modes and controlling disruptions.

52462 ECH on the MTX. Stallard, B. (Lawrence Livermore National Laboratory, Livermore, CA (USA)); Byers, J.; Hooper, B.; Meassick, S.; Rice, B.; Rognlien, T.; Verboncoeur, J.; Makowski, M.A. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 84-87 (1 Jul 1989). DOE Contract W-7405-ENG-48. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The Microwave Tokamak Experiment (MTX) at LLNL is investigating the heating of high density Tokamak plasmas using an intense pulse FEL. Our first experiments, now beginning, will study the absorption and plasma heating of single FEL pulses (20 ns pulse length and peak power up to 2 GW) at a frequency of 140 GHz. A later phase of experiments also at 140 GHz (FY 90) will study FEL heating at 5 kHz rate for a pulse train up to 50 pulses (35 ns pulse length and peak power up to 4 GW). Future operations are planned at 250 GHz with an average power of 2 MW for a pulse train of 0.5 s. The microwave output of the FEL is transported quasi-optically to the tokamak through a window-less, evacuated pipe of 20 in diameter, using a six mirror system. Computational modelling of the non-linear absorption for the MTX geometry predicts single-pass absorption of 40% at a density and temperature of 1.8×10^{20} m^{-3} and 1 keV, respectively. To measure plasma microwave absorption and backscatter, diagnostics are available to measure forward and reflected power (parallel wire grid beam-splitter and mirror directional couplers) and power transmitted through the plasma (segmented calorimeter and waveguide detector). Other fast diagnostics include ECE, Thompson scattering, soft x-rays, and fast magnetic probes.

52463 Particle transport during ERCH on the TEXT tokamak. Richards, B. (Fusion Research Center, University of Texas, Austin, TX (USA)); Gentle, K.W.; Sing, D.C.; Phillips, P.E.; Rowan, W.L.; Wootton, A.J.; Brower, D.L.; Luhmann, N.C.; Peebles, W.A.; Cima, G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 72-75 (1 Jul 1989). DOE Contract FG05-88ER53267 ;FG03-86ER53225. (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Particle transport coefficients during TEXT discharge have been determined using a modulated-gas feed technique. Comparisons made before and during electron cyclotron heating experiments have shown that the largest effect on transport is an increase in particle diffusion at the periphery of the plasma.

52464 Modeling of LH current drive in self-consistent elongated tokamak equilibria. Blackfield, D.T. (Lawrence Livermore National Laboratory, Livermore, CA (USA)); Devoto, R.S.; Fenstermacher, M.E.; Bonoli, P.T.; Porkolab, M.; Yugo, J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 114-117 (1 Jul 1989). DOE Contract W-7405-ENG-48. (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

A LH simulation code has been used to simulate elongated plasmas with numerically generated equilibra. The model includes ray tracing using a dispersion relation with electromagnetic and thermal effects and the solution of a 1D Fokker-Planck equation with quasi-linear diffusion on each radial surface. Results are presented for a study of LH drive in ITER. (AIP)

52465 Achievement of second stability by means of lower hybrid current drive. Bonoli, P.T. (Plasma Fusion Center, MIT, Cambridge, MA (USA)); Porkolab, M.; Blackfield, D.T.; Devoto, R.S.; Fenstermacher, M.E. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 118-121 (1 Jul 1989). (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

It is shown that profiles of the safety factor, necessary to access a high beta operating regime in shaped, low aspect ratio tokamaks, can be achieved via off-axis lower hybrid current drive (LHCD). In order to accurately access this RF current generation, a simulation model for LHCD has been extended to noncircular equilibria and combined with an MHD equilibrium solver. Model results will be presented for Versator Upgrade parameters.

52466 Pulsed lower-hybrid wave penetration in reactor plasmas. Cohen, R.H. (Lawrence Livermore National Laboratory, Livermore, CA (USA)); Bonoli, P.T.; Porkolab, M.; Rognlien, T.D. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 126-129 (1 Jul 1989). DOE Contract W-7405-ENG-48. (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Providing lower-hybrid power in short, intense (GW) pulses allows enhanced wave penetration in reactor-grade plasmas. We examine nonlinear absorption, ray propagation, and parametric instability of the intense pulses. We find that simultaneously achieving good penetration while avoiding parametric instabilities is possible, but imposes restrictions on the peak power density, pulse duration, and/or r.f. spot shape. In particular, power launched in narrow strips, elongated along the field direction, is desired.

52467 Wave propagation in a tokamak at lower hybrid frequencies. Stevens, D.C. (Courant Institute of Mathematial Sciences New York University, New York, NY (USA)); Weitzer, H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 178-181 (1 Jul 1989). DOE Contract FG02-86ER53223. (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Maxwell's equations with the cold plasma dielectric tensor are solved to study wave prpagation and absorption in a tokamak at lower hybrid frequencies. A resonance other than conventional lower hybrid resonance is exhibited and is shown to be extremely sharp. Numerical limitations of this technique are discussed.

52468 Multiple-use plasma laboratory for graduate fusion education. Hankins, O.E.; Gilligan, J.G.; Wehring, B.W.; Bourham, M.; Auciello, O.H. *Transactions of the American Nuclear Society (USA),* 59: 106-107 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

In a climate of tight fusion research and teaching laboratory budgets, it has become necessary to utilize equipment obtained for research purposes in the teaching program. Likewise, it is desirable to use plasma research equipment from nonfusion projects to support basic understanding of general plasma concepts. Multiple experiments can also be done on a single device. The plasma laboratory that has been developed at North Carolina State University in the last 4 yr incorporates all of the aforementioned ideas to support a 3-credit-hour hands-on laboratory course for graduate students. Incorporating teaching and research into the fusion plasma laboratory maximizes the resources and gives students experience on actual research tools. 2 refs.

52469 Interpretation of momentum confinement in recent JET [Joint European Torus] and TFTR [Tokamak Fusion Test Reactor] experiments. Pautasso, G.; Stacey, W.M. *Transactions of the American Nuclear Society (USA),* 59: 108-109 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Unbalanced neutral beam injection, used to heat tokamak plasmas, causes the plasma to rotate. It is well documented that the observed momentum confinement time cannot be explained by the existing neoclassical theory of perpendicular viscous momentum transfer. Analysis of Impurity Study Experiment-B, Poloidal Divertor Experiment, and Princeton Large Torus PDX, and data based on the more recent gyroviscous theory of momentum confinement, however, showed good agreement between theory and experiment. In this paper, results from recent Joint European Torus (JET) and Tokamak Fusion Test Reactor (TFTR) experiments in which the various plasma parameters were measured with a good degree of accuracy are presented and shown to be in agreement with the prediction of the gyroviscous theory. 6 refs., 2 figs.

52470 Streak cameras capture x-ray laser emissions. Stradling, G.L. (Los Alamos National Lab., NM (USA). Physics Div.). *Laser Focus with Fiberoptic Communications (USA),* 26(5): 215-226 (May 1990).

The soft x-ray streak camera is a versatile tool for exploring the challenging spectrum of x-ray emissions from the UV through the XUV up to tens of kilovolts in x-ray photon energy. When coupled with an appropriate spectrometer or x-ray imaging optic, the streak camera can provide time-resolved spectral or spatial images with a resolution limit of a few picoseconds. The author discusses soft x-ray streak cameras have many applications. In laser-fusion studies, they probe the hot, high-density regions of the fusion implosions and provide information on the compression and re-expansion of the pellet under the intense pressure of the plasma blow-off. These instruments have allowed to probe the supercritical region of laser plasmas to measure the temperature of the target and the energy flow in the laser deposition region with temporal resolution of tens

of picoseconds. They have also been used to explore x-ray laser operation in various experiments.

52471 ICRF coupling on TFTR using the PPL antenna. Greene, G.J. (Princeton Plasma Physics Laboratory Princeton, NJ (USA)); Colestock, P.L.; Hosea, J.C.; Phillips, C.K.; Smithe, D.N.; Stevens, J.E.; Wilson, J.R.; Gardner, W.; Hoffman, D. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 254-258 (1 Jul 1989). DOE Contract AC02-76CH03073. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Coupling of the PPL ICRF antenna to the TFTR plasma is experimentally measured as $R_c=P/I^2$, where P is the net power dissipate and I is the RF current at a point in the resonant loop. The relation of R_c to the equivalent antenna loading resistance is investigated using a transmission line model that includes the antenna structure and the feedthroughs. Coupling has been experimentally characterized for a variety of discharge conditions including H and ^{3}He minority, D and ^{4}He majority plasmas. Effects of antenna phasing, D neutral beam injection, RF power level, plasma density aned position are discussed. Distinct and reproducible eigenmodes in the loading are observed in H-minority, D-majority plasma during the density rise accompanying neutral beam injection. A 1-D wave propagation model has reproduced the general structure of the modes. For 0-π toroidal phasing, the modes arise from radial reflections from both the reonance-absorption layer and the inner wall of the tokamak; for 0–0 phasing, the modes result from toroidal interference.

52472 Comparison between the dielectric-filled rectangular and vacuum folded waveguide as fast-wave launchers in the ICRF. Lam, N.T. (University of Wisconsin, Madison, WI (USA)); Scharer, J.E.; Eldridge, O.C. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 286-289 (1 Jul 1989). DOE Contract FG02-86ER53218. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

In reactor situations, a waveguide may have certain advantages (such as power handling capability and structural rigidity) over loop antennas as fast wave launchers in tokamaks. We carry out a numerical analysis of a dielectric-filled rectangular waveguide, using a formalim that gives the wave reflection coefficient from the plasma (or the equivalent plasma impedance), once the plasma surface admittance tensor and the eigenmodes of the unloaded launcher are known. In the context of a slab model, we obtain the plasma surface admittance tensor by solving the wave differential equations in a cold plasma, assuming a radiation condition from inside the plasma. The eigenfunctions of the rectangular waveguide are readily written down. For the vacuum folded waveguide, semi-analytical expressions for the TE mode eigenfunctions hasve been obtained by a Ritz variational method. Some problems concerning the calculation of the reflection coefficient for a folded waveguide are discussed.

52473 60 MHz fast wave current drive experiment for DIII-D. Mayberry, M.J. (General Atomics, San Diego, CA (USA)); Chiu, S.C.; Porkolab, M.; Chan, V.; Freeman, R.; Harvey, R.; Pinsker, R. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 298-301 (1 Jul 1989). DOE Contract AC03-89ER52153. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The DIII-D facility provides an opportunity to test fast wave current drive appoach. Efficient FWCD is achieved by direct electron absorption due to Landa damping and transit time magnetic pumping. To avoid competing damping mechamisms we seek to maximize the single-pass asorption of the fast waves by electrons. (AIP)

52474 Theoretical studies of ICRH in stellaratores and tokamaks. Moroz, P.E. (MIT Plasma Fusion Center, Cambridge, MA (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 302-305 (1 Jul 1989). (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

All stellarators can be divided into two classes depending on the parameters ζ_s, which can be easily expressed through the main parameters of stellarator. Features of cyclotron absorption and mode conversion during fast wave ICR plasmas heating are considered. The enhancement due to effect of non-zero $(\mathbf{B}\cdot\nabla)\mathbf{B}$ in the regime of majority fundamental cyclotron resonance is discussed.

52475 Ion Bernstein wave heating experiments on PBX-M. Ono, M. (PPPL, Princeton University, Princeton, NJ (USA)); Greene, G.J.; Bernabei, S. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 306-309 (1 Jul 1989). DOE Contract AC02-76CH03073. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

A multi-megawatt level IBWH experiment on PBX-M[1] is in preparation. The goal of the expriment is to contribute to the attainment of the high beta, second regime of stability. The high power IBWH will be used as an additional heating power source to supplement the existing 6 MW of NBI power to achieve higher β values in PBX-M. Bulk ion heating via IBW excitation with localized, off-axis deposition can be used to modify the pressure profile for improved plasma stability at high β. The high power off-axis heating in principle can generate a significant boostrap current [2]($\approx$30%) in the outer region of the PBX-M plasma complementing LHCD for broadening the current profiles. It is also interesting to note that the available rf power ($\approx$4 MW) is comparable to the predicted power levels required for the rf ponderomotive stabilization of pressure driven modes (such as the high-n ballooning[3] and external kink modes[4]) for the closely fitted stabilizing shell configuration of PBX-M. There are, however, several experimental factors that require careful consideration in planning a high power experiment. Four important factors are discussed here in some detail: 1. Antenna location. 2. Effects of parallel electric fields. 3. Modification of launched wave spectrum due to antenna misalignement 4. Possible interference of wave launching by protective limiters.

52476 ICRF Faraday shield plasma sheath physics: the Perkins paradigm. Wealton, J.H. (Oak Ridge National Laboratory, Oak Ridge, TN (USA)); Ryan, P.M.; Raridon, R.J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 366-369 (1 Jul 1989). DOE Contract AC05-84OR21400. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Using a 2-D nonlinear formulation which considers the plasma edge near a Faraday shield in a self consistent manner, progress is indicated in the modeling of the ion motion for a Perkins embodiment. Ambiguities in the formulation are also indicated, the resolution of which will provide significant insight into the impurities generation for ICRH antennas.

52477 Analytic theory of ICRF minority heating. Ye, H. (Physics Department, University of California, Berkeley, CA (USA)); Kaufman, A.N. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 374-377 (1 Jul 1989). DOE Contract AC03-76SF00098. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

We present a one-dimensional analytic theory of the ICRF gyroresonant absorption and mode-conversion, for the problem of minority fundamental resonance. Using the wave phase-space method, and the theory of linear mode conversion therein, we obtain explicit expressions for the coeficients of transmission (*T*), reflection (*R*), conversion (*C*), absorption (*A*).

52478 A fast-wave current drive system design for ITER. Yugo, J.J. (Fusion Engineering Design Center, Oak Ridge, TN (USA)); Batchelor, D.B.; Goranson, P.L.; Goulding, R.H.; Jaeger, E.F.; Ryan, P.M. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 378-384 (1 Jul 1989). DOE Contract AC05-84OR21400. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The development of an efficient current drive system is an essential factor in a steady-state tokamak reactor. For the International Thermonuclear Experimental Reactor (ITER) one of the current drive systems being considered is fast wave current drive (FWCD) in the ion cyclotron range of frequencies (ICRF), supplemented by lower hybrid current drive (LHCD) in the low density edge plasma, although LHD can also be utilized for current ramp-up. Three of the candidate current drive systems (neutral beams,

electron cyclotron and ion cyclotron fast wave) presently have deficiencies either in the technology of sources and transmission systems or in the experimental physics basis. Engineering design and integration of each system will contribute to the basis on which the eventual system choice can be made. This FWCD system design begins to define and address the issues related to implementing such a system on a steady-state tokamak reactor. Plasma modeling by Batchelor, Carter, and Jaeger[1] at ORNL with the two-dimensional, full-wave code ORION[1] provides the basis on which this system has been designed.

52479 RF power applications for ITER. Ehst, D.A. (Argonne National Laboratory, Argonne, IL (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 393-401 (1 Jul 1989). (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Current drive and heating in the steady state phase of the International Thermonuclear Experimental Reactor are discussed. Roles of various RF technologies for current drive and heating are compared. Low cost equipment, flexible to provide multiple applications appears highly desirable. (AIP)

52480 Determination of fields near an ICRH antenna using a 3D magnetostatic laplace formulation. Ryan, P.M. (Oak Ridge National Laboratory, Oak Ridge, TN (USA)); Rothe, K.E.; Wheaton, J.H.; Swain, D.W. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 322-325 (1 Jul 1989). DOE Contract AC05-84OR21400. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

In the vicinity of an ICRH antenna strap, where there are no volume currents and a free-space wavelength is much longer than the dimensions of interest, Ampere's law reduces to a curl-free condition on the magnetic field, allowing a magnetic scalar potential to be defined. This scalar potential is a solution of the three-dimensional (3D) Laplace equation and satisfies the following boundary conditions on the magnetic field: (1) the line integral of the mgnetic field around the current strap is equal to the current flowing the strap and (2) the perpendicular component of the magnetic field vanishes at conductor surfaces (no flux penetrasion of perfect conductors). This formulation allows for the magnetic field solution of quite complex 3D geometries, such as poloidal current straps with asymmetric radial feeds or detailed Faraday shield geometries.

52481 Peaked density profiles in circular-limiter *H* modes on the TFTR tokamak. Bush, C.E.; Goldston, R.J.; Scott, S.D.; Fredrickson, E.D.; McGuire, K.; Schivell, J.; Taylor, G.; Barnes, C.W.; Bell, M.G.; Boivin, R.L.; Bretz, N.; Budny, R.V.; Cavallo, A.; Efthimion, P.C.; Grek, B.; Hawryluk, R.; Hill, K.; Hulse, R.A.; Janos, A.; Johns *Physical Review Letters (USA),* 65(4): 424-427 (23 Jul 1990). DOE Contract AC02-76CH03073.

Circular-limiter *H* modes are obtained on the TFTR tokamak during high-power neutral-beam heating. The transition is usually from the supershot to the *H* mode rather than the usual *L* to *H* transition, and thus is obtained in a low-recycling environment with core fueling mainly from the heating beams. As a result, the density and pressure profiles are highly peaked at the center. The global confinement time τ_E is enhanced over *L*-mode scaling by up to $\approx$2.5 times. The onset of edge-localized MHD modes shortly after the *H*-mode transition appears to limit τ_E. Limiter *H* modes of up to 1.5 s duration have been realized.

52482 Investigation of ion-acoustic-decay-instability thresholds in laser-plasma interactions. Mizuno, K. (Plasma Physics Research Institute, University of California, Lawrence Livermore National Laboratory, Livermore, CA (USA)); Young, P.E.; Seka, W.; Bahr, R.; De Groot, J.S.; Drake, R.P.; Estabrook, K.G. *Physical Review Letters (USA),* 65(4): 428-431 (23 Jul 1990).

The ion acoustic decay instability has been studied by monitoring the Stokes sideband of the second-harmonic emission from a laser-produced plasma. The intensity threshold decreased as the laser spot size increased. It reached homogeneous-plasma collisional values in planar plasmas produced using large laser spot sizes ($D \gtrsim 600$ μm), for laser wavelengths of either 1.06 or 0.53 μm. These observations show that the ion acoustic decay instability may well play a more important role in laser fusion that had been generally believed.

52483 Plasma tomography using transient synchrotron radiation. Fisch, N.J. (Plasma Physics Laboratory, Princeton University, Princeton, NJ (USA)); Kritz, A.H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 414-417 (1 Jul 1989). DOE Contract AC02-76CH03073 ;FG02-84ER53187. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

We show by means of an example in a six-dimensional parameter space that induced transient radiation can inform on the dc electric field and other tokamak parameters.

52484 Analytic expression for mode conversion of electrostatic and electromagnetic waves. Hinkel-Lipsker, D.E. (Dept. of Physics, University of California, Los Angeles, CA (USA)); Fried, B.D.; Morales, G.J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 422-425 (1 Jul 1989). (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

We have derived analytic expressions, in terms of Airy functions, for the fields and for the reflection and mode conversion coefficients of Langmuir and electromagnetic waves in an inhomogeneous, unmagnetized plasma. Our results, which are valid in the limit of nonrelativistic electron temperature, $T/mc^2 \ll 1$, agree with earlier numerical calculations.

52485 Ponderomotive forces, three-wave coupling, and the bispectrum. Intrator, T. (Dept. Nuclear Engineering & Engineering Physics, University of Wisconsin, Madison, WI (USA)); Meassick, S. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 426-429 (1 Jul 1989). DOE Contract FG02-88ER53264. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

In the Phaedrus-B Tandem Mirror plasma, antennas launch waves with high enough energy density $\delta B^2/8\pi nT \sim 3\times10^{-3}$ that ponderative forces can be significant. These effects are low frequency forces due to spatial gradients of high frequency (RF) wave fields, and have allowed us to experimentally verify the essential physical assumptions and conclusions of the theory and model. The three-wave interaction is composed of applied RF, MHD and parametric coupled sideband waves. The Bispectrum, a Fourier transformed cubic correlation, is used to measure the local magnitude and phase of the three-wave interaction at each point in space, enabling a direct connection between experiment and theory. Wave-wave coupling of the type described by this approach an diagnosable with the Bispectrum may be important in auxiliary ICRF heated tokamaks.

52486 Green's function for RF-driven current in a toroidal plasma. Karney, C.F.F. (Plasma Physics Laboratory, Princeton University, Princeton, NJ (USA)); Fisch, N.J.; Reiman, A.H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 430-433 (1 Jul 1989). DOE Contract AC02-76CH03073. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The Green's function for rf-driven currents in a toroidal plasma is calculated in the long mean-free-path limit.

52487 RF induced transport in tokamak plasmas. Kupfer, K. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, MA (USA)); Bers, A.; Ram, A. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 434-437 (1 Jul 1989). DOE Contract AC02-78ET51013. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

We investigate the effects of coherent RF wave-fields on the transport of particles in a tokamak by coupling the chaos induced in velocity spacce to particles' radial guiding center drifts. In the following calculation, it is shown that localized, phase coherent structures can induce transport fluxes which are outside the scope of conventional random-phase theories.

52488 Power deposition and field penetration in a field-reversed configuration generated by rotating magnetic fields. Kuthi, A. (University of California, Los Angeles, CA (USA)); Zwi, H.; Wells, B.; Wong, A.Y. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 438-441 (1 Jul 1989). DOE

Contract FG03-86ER53225. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Power deposition profiles derived from measured equilibrium and field-penetration profiles in the RACETRACK rotating magnetic field drived FRC are presented. It is found, that significantly higher RF power can be deposited in the plasma than what is necessary to maintain the diamagnetic current. The Klima relations are reconciled with the higher power input because the excess power is delivered by waves possessing zero net angular momentum. Only the right-hand rotating component of the RF field penetrates fully, and this results in correct circular polarization of the fields on axis regardless of the imposed polarization by the antennas.

52489 **Microinstabilities effect on MHD modes.** Litwin, C. (University of Wisconsin, Madison, WI (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 442-445 (1 Jul 1989). DOE Contract FG02-88ER53264. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The ponderomotive force due to high-frequency microinstabilities can affect the low-frequency macrostability. Two examples of this phenomenon are discussed. It is shown that an α particle loss-cone instability stabilizes the flute mode of an ignited, axisymmetric mirror plasma. In tokamaks, the ion-whistler instability, driven by an anisotropic population of energetic particles, stabilizes the internal kink mode for JET range of parameters.

52490 **RF current drive and helicity injection.** Mett, R.R. (University of Wisconsin-Madison, Madison, WI (USA)); Tataronis, J.A. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 446-449 (1 Jul 1989). DOE Contract FG02-88ER53264. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

Recent studies suggest that low frequency electromagnetic waves possessing helicity may drive currents in plasmas with greater efficiency than schemes based on linear momentum transfer to charged particles.[1,2] A key issue is the transfer of wave helicity into the helicity of the equilibrium magnetic field. Previously we examined the conversion mechanism by following the dynamics of a packet of arbitrarily polarized Alfven waves propagating in an infinite uniformly magnetized plasma.[3,4] Analysis of the equations of magnetohydrodynamics with resistivity and viscosity yielded a set of nonlinear equations governing the Alfven wave amplitude and an induced magnetic field. Solutions for the initial value problem[4] related the induced plasma current to the helicity of the wave and the difference between the magnetic diffusivity and viscosity. In the present investigation we examine solutions for the boundary value problem.

52491 **M=−1 Alfven wave beach heating of two-ion mirror plasmas.** Roberts, D.R. (University of Wisconsin, Madison, WI (USA)); Hershkowitz, N.; Majeski, R.; Edgell, D.H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 462-465 (1 Jul 1989). DOE Contract FG02-88ER53264. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

RF heating experiments in the central cell of the Phaedrus-B tandem mirror have utilized a rotating field antenna set to excite m=−1 cylindrical eigenmodes for hydrogen cyclotron resonance heating at a magnetic beach. Recent investigations have examined modifications to this heating imposed by the addition of deuterium or helium ion species. In addition to nearly 50% increases in T_i, we have observed evolution of the radial heating profiles with n_M/n_H (M=D or He). In particular, we discuss the correspondence of our observations with the predicted variations with n_m/n_H in the antenna-wave coupling to the slow ion-cyclotron global and fast magnetosonic surface wave eigenmodes.

52492 **Emission of ion and electron cyclotron harmonic radiation from mode conversion layers.** Swanson, D.G. (Department of Physics, Auburn University, AL (USA)); Cho, S. *AIP Conference Proceedings (American Institute of Physics) (USA),* 190(1): 474-477 (1 Jul 1989). DOE Contract FG05-85ER53206. (CONF-8905120–: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The asymmetry of cyclotron radiation from a mode conversion layer is presented for harmonics of the ion cyclotron frequency and the second harmonic of the electron cyclotron frequency for weakly relativistic electrons. The same form of Kirchhoff's law is found for all cases, relating the emission along each branch to the absorption of an incident wave along the corresponding branch. Results show that the fast wave radiation is more strongly asymmetric at the third harmonic than at the second harmonic of the ion cyclotron frequency, while the slow wave radiation ratio is about same. At the second cyclotron harmonic of weakly relativistic electrons, the asymmetry of radiation is found to be small at high temperature. The effect of equilibrium Bernstein wave radiation is also discussed.

52493 **Turbulent enhancement of particle and heat fluxes during sawtooth oscillations in a tokamak edge plasma.** Rhodes, T.L. (Fusion Research Center, The University of Texas, Austin, TX (USA)); Ritz, C.P.; Lin, H. *Physical Review Letters (USA),* 65(5): 583-586 (30 Jul 1990). DOE Contract FG05-88ER53267.

Using Langmuir probes in the edge plasma of the TEXT tokamak we have identified sawtooth oscillations in density, potential, and temperature. Concurrent with the sawtooth oscillations are increases in the density and potential fluctuation levels which result in significant increases in the fluctuation-driven particle flux and associated heat flux. No changes in the basic turbulence mechanism were observed during the sawtooth passage.

52494 **Halo feedback control of trapped particle instabilities.** Sekiguchi, A. (Columbia Univ., New York, NY (USA). Plasma Physics Lab.); Sen, A.K.; Navratil, G.A. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 685-686 (Jun 1990). Grant ECS-86-16322.

This paper reports a collisionless, curvature-driven trapped-particle instability stabilized by a novel remote-stabilization scheme in the Columbia linear machine (CLM). The control signal is applied via a segmented endplate to the halo-plasma region which is cooler and lower in density than the core plasma. The method can be considered as a generic control scheme for the suppression of some instabilities in a variety of plasma devices, including reactor-type machines.

52495 **Transport of long-pulse, high-current electron beams in preformed monatomic plasma channels in the ions focus regime.** Miller, J.D. (Naval Surface Warfare Center, Silver Spring, MD (US)); Gilgenbach, R.M. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(3): 658-663 (Jun 1990).

Experiments have been performed demonstrating the efficient transport of long-pulse, high-current electron beams in well-diagnosed, preformed plasma channels. Channels were created by the low-energy electron-beam ionization of low-pressure monatomic gases. These transport efficiencies are comparable to the optimum values obtained for similar pulselengths in previous long-pulse, electron-beam transport experiments in laser-preionized diethylaniline gas. Experimental results show the development of both transverse current centroid oscillations characteristic of the ion hose instability and the microwave emission indicative of relativistic electron beam-plasma electron two-stream instability. Significant microwave emission indicating rapid growth of the two-stream instability has been observed in the *S*-band when the space-charge neutralization fraction f_e exceeds unity.

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Refer also to citation(s) 50856, 51449, 51456, 52230, 52307, 52377, 52380, 52381, 52382, 52383, 52384, 52385, 52387, 52388, 52389, 52390, 52392, 52393, 52396, 52397, 52398, 52409, 52410, 52411, 52412, 52413, 52414, 52415, 52417, 52418, 52420, 52421, 52422, 52423, 52424, 52425, 52426, 52428, 52429, 52430, 52431, 52432, 52435, 52436, 52438, 52439, 52440, 52441, 52442, 52443, 52454, 52478, 52479, 52586

52496 (CONF-900623–20) **A brief review of cavity swelling and hardening in irradiated copper and copper alloys.** Zinkle, S.J. Oak Ridge National Lab., TN (USA). [1990]. 41p. Sponsored

by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE91000554. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The literature on radiation-induced swelling and hardening in copper and its alloy is reviewed. Void formation does not occur during irradiation of copper unless suitable impurity atoms such as oxygen or helium are present. Void formation occurs for neutron irradiation temperatures of 180 to 550°C, with peak swelling occurring at ~320°C for irradiation at a damage rate of 2×10^{-7} dpa/s. The post-transient swelling rate has been measured to be ~0.5%/dpa at temperatures near 400°C. Dispersion-strengthened copper has been found to be very resistant to void swelling due to the high sink density associated with the dispersion-stabilized dislocation structure. Irradiation of copper at temperatures below 400°C generally causes an increase in strength due to the formation of defect clusters which inhibit dislocation motion. The radiation hardening can be adequately described by Seeger's dispersed barrier model, with a barrier strength for small defect clusters of $\alpha \approx 0.2$. The radiation hardening apparently saturates for fluences greater than $\sim 10^{24}$ n/m^2 during irradiation at room temperature due to a saturation of the defect cluster density. Grain boundaries can modify the hardening behavior by blocking the transmission of dislocation slip bands, leading to a radiation- modified Hall-Petch relation between yield strength and grain size. Radiation-enhanced recrystallization can lead to softening of cold-worked copper alloys at temperatures above 300°C.

52497 (CONF-900623–21) **A theoretical model of accelerated irradiation creep at low temperatures by transient interstitial absorption.** Stoller, R.E.; Grossbeck, M.L.; Mansur, L.K. Oak Ridge National Lab., TN (USA). [1990]. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE91000705. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A theoretical model has been developed using the reaction rate theory of radiation effects to explain experimental results that showed higher than expected values of irradiation creep at low temperatures in the Oak Ridge Research Reactor. The customary assumption that the point defect concentrations are at steady state was not made; rather, the time dependence of the vacancy and interstitial concentrations and the creep rate were explicitly calculated. For temperatures below about 100 to 200°C, the time required for the vacancy concentration to reach steady state exceeds the duration of the experiment. For example, if materials parameters typical of austenitic stainless steel are used, the calculated vacancy transient dose at 100°C is about 100 dpa. At 550°C this transient is over by 10^{-8} dpa. During the time that the vacancy population remains lower than its steady state value, dislocation climb is increased since defects of primarily one type are being absorbed. Using the time-dependent point defect concentrations, the dislocation climb velocity has been calculated as a function of time and a climb-enabled glide creep model had been invoked. The extended transient time for the vacancies leads to high creep rates at low temperatures. In agreement with the experimental observations, a minimum in the temperature dependence of creep is predicted at a temperature between 50 and 350°C. The temperature at which the minimum occurs decreases as the irradiation dose increases. Predicted values of creep at 8 dpa are in good agreement with the results of the ORR-MFE-6J/7J experiment.

52498 (CONF-901116–9) **Potential applications of a new microwave ECR [electron cyclotron resonance] multicusp plasma ion source.** Tsai, C.C. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 11. international conference on the application of accelerators in research and industry; Denton, TX (USA); 5-8 Nov 1990. Order Number DE91000707. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new microwave electron cyclotron resonance (ECR) multicusp plasma ion source using two ECR plasma production regions and multicusp plasma confinement has been developed at Oak Ridge National Laboratory. This source has been operated to produce uniform and dense plasmas over large areas of 300 to 400 cm^2. The plasma source has been operated with continuous argon gas feed and pulsed microwave power. The discharge initiation phenomena and plasma properties have been investigated and studied as functions of discharge parameters. Together with the discharge characteristics observed, a hypothetical discharge mechanism for this plasma source is reported and discussed. Potential applications, including plasma and ion-beam processing for manufacturing advanced microelectronics and for space electric propulsion, are discussed. 7 refs., 6 figs.

52499 (CONF-9002100–, pp. 229-248) **Organization of the ITER [International Thermonuclear Experimental Reactor] Project - Sharing of information and procurements.** Shannon, T.E. (Fusion Engineering Design Center, Oak Ridge, TN (USA)). Oak Ridge National Lab., TN (USA). May 1990. From International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990. In *IGORR-1: Proceedings of the first meeting of the international group on research reactors.* 262p. Order Number DE90012973. Source: NTIS, PC A12/MF A01.

The International Thermonuclear Experimental Reactor (ITER) project is expected to fully confirm the scientific feasibility and to address the technological feasibility of fusion power. Consequently, the machine must be designed for controlled ignition and extended burn of deuterium-tritium plasma. It must also demonstrate and perform integrated testing of components required to utilize fusion power for practical purposes. Cooperation among four countries/organizations (United States, Soviet Union, Japan, and EURATOM) to build a single experimental reactor will reduce the cost for each country and provide an international pool of scientific and engineering resources. This paper describes ITER organization for conceptual design activity, schedule for conceptual design activities, ITER operating parameters, conceptual project schedule and cost, future plans, basic principles and problems related to task sharing, and basic principles in handling of intellectual property.

52500 (CONF-9009264–1) **Helium effects on the mechanical properties of neutron-irradiated Cr-Mo ferritic steels.** Klueh, R.L. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Conference on the effect of irradiation on materials of fusion reactors; Leningrad (USSR); 18-20 Sep 1990. Order Number DE91000390. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the first wall of a fusion rector, large amounts of transmutation helium will be produced simultaneously with the displacement damage caused by high-energy neutrons from the fusion reaction. One method used to simulate irradiation effects for ferritic steels is to add nickel to the steels and irradiate them in a mixed-spectrum reactor. Fast neutrons in the spectrum produce displacement damage, while transmutation helium is produced by a two-step reaction of ^{58}Ni with thermal neutrons. This technique has been used to investigate the effect of helium on tensile properties and toughness. Results from these studies are summarized.

52501 (IAE–4644-8) **High-energy neutron propagation through nonuniformities in a blanket and shields of a thermonuclear reactor.** Zimin, S.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 21p. (In Russian). Order Number DE91602956. Source: NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Calculational results of propagation of high-energy neutrons through channels and slip gaps of a thermonuclear testing reactor (TTR) are presented. Calculations are carried out in two-dimensional plane geometry for a scheme of material composition of the internal blanket and TTR protection with two coaxial and noncoaxial and with curved gaps, direct vacuum channels and channels with water and steel. Neutron fluences with E=14 MeV and E>0.1 MeV during 5MWxyears/m^2 of reactor operation are considered. 9 refs.; 17 figs.

52502 (IAEA-CN–53/F-2-2) **ITER [International Thermonuclear Experimental Reactor]: Nuclear engineering.** Baker, C. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-901025–10: 13. international conference on plasma

physics and controlled nuclear fusion research, Washington, DC (USA), 1-6 Oct 1990). Order Number DE91000713. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An overview of ITER efforts in the area of nuclear engineering and technology is presented in this paper. It includes technological and design developments for the three major tokamak in-vessel components: blanket, first wall, divertor plates and the tritium fuel cycle. A summary of the on-going R&D is also included. 13 refs.

52503 (JAERI-M–90-086) **Modification of JT-60 NBI system from quasi-perpendicular to tangential injection.** Matsuoka, Mamoru (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Akino, Noboru; Ebisawa, Noboru. Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 116p. (In Japanese). Order Number DE91712978. Source: NTIS (US Sales Only), PC A06/MF A01.

Modification of the JT-60 NBI system from quasi-perpendicular to tangential injection is studied. The motivation is that the ripple loss of fast ions would be substantial with the present quasi-perpendicular NBI in the upgraded JT-60 since in the upgrading modification the tokamak vacuum vessel is replaced to a larger bore one while toroidal coils are unchanged and hence toroidal field ripples at the periphery of plasmas increase. How many units of the present seven pairs of upper and lower units should be modified, and then how to combine them to inject beams through limited ports are discussed. The modification is optimized to utilize present beam line components as many as possible but is found to be still a complex task. This is because all present components are specialized to the present large slant angle of ±35.5 degrees. In this report, studies are presented on the necessity and the method of the modification. (author).

52504 (JAERI-M–90-087) **Experimental study of radiation losses on the JT-60 tokamak.** Nishitani, Takeo (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 192p. Order Number DE91712979. Source: NTIS (US Sales Only), PC A09/MF A01.

Bolometric measurement system and associated diagnostics, soft x-ray pulse-height-analyzer, soft x-ray intensity and Balmer α line measurement systems, were developed to investigate the radiation losses of the JT-60 plasmas. The bolometric measurement is the most important diagnostics in the radiation loss study. The soft x-ray pulse-height-analyzer is useful to estimate the metallic impurity concentration, and the soft x-ray intensity and Balmer α line measurements are monitors of radiation in x-ray region and particle recycling in the plasma edge, respectively. In JT-60, the marfe has been observed frequently in high-Ip and high density limited discharges with NB heating after the replacement of the first wall from TiC coated molybdenum tiles to graphite ones. The threshold electron density of the marfe onset increased with the NB power. The empirical scaling of the marfe onset taking account of the NB power was obtained. This scaling was useful to predict the marfe onset condition in NB heated discharges on JT-60. The marfe was modelled based on the radiative thermal instability. The simple model can explain the marfe onset condition. The radiated power from the plasma with marfe was about 90 % of the absorbed power. Both stored energy and central electron temperatures did not change by the marfe onset in spite of the such intense radiation loss. Finally, this study revealed that the most clean plasma was obtained in the metallic first wall with the divertor on JT-60. This fact is suggesting the capability of the metallic material for the first wall of next devices. Enhance radiation localized in the peripheral plasma such as marfe and IDC does not degrade the core plasma confinement or somewhat improves it, so that marfe and IDC are suitable operational regime in the high density region for future devices because they have strong remote-radiative-cooling-effect. (J.P.N.).

52505 (JAERI-M–90-090) **Overview of FER (Fusion Experimental Reactor): FY 1989 report.** Japan Atomic Energy Research Inst., Tokyo (Japan). Jun 1990. 102p. (In Japanese). Order Number DE91713025. Source: NTIS (US Sales Only), PC A06/MF A01.

The FER (Fusion Experimental Reactor) project is proposed to construct a next generation tokamak machine in Japan, in order to take a leadership in realizing a fusion reactor under international cooperation. The FER is the machine, which comes in between the present large tokamak machines like the JT-60 and the DEMO reactor for power generation. The mission of the FER is to realize a long controlled burn and to develop and test major fusion component technologies, super conducting magnet and breeding blanket and so on, that is, to demonstrate the engineering feasibility of a fusion reactor. The conceptual design of the FER was started in 1980. In April 1988, a new organization (Fusion Experimental Reactor Team) was constructed to support the ITER activities and also to design the FER. In order to make the FER and the ITER complementary, the FER concept was reconsidered. The FER described in this report is a new version, and the conceptual design will be finished in December, 1990. (author).

52506 (JAERI-M–90-119) **Evaluation tests on first wall and divertor plate materials for JT-60 upgrade.** Yamamoto, Masahiro (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Ando, Toshiro; Takatsu, Hideyuki. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1990. 83p. (In Japanese). Order Number DE91713082. Source: NTIS (US Sales Only), PC A05/MF A01.

This report describes material tests performed to evaluate various grades of isotropic graphite and newly developed carbon/carbon (C/C) composite for application to first wall and divertor plate of JAERI Tokamak-60 Upgrade (JT-60U). Physical and mechanical properties of these materials have been measured by using identical test pieces and testing machines. Based on the obtained data, the evaluation has been made mainly from thermal conductivity, thermal shock and mechanical strength points of view. Limitations on manufacturing size and lead time are also investigated as well as structural applicability to the actual plasma facing tiles. Furthermore, outgassing properties and erosion characteristics against high heat flux are considered in selecting the materials. It is found from these tests that several kinds of 2-D felt type C/C composite have superior thermal conductivity in the range of 300 - 400 W/mK at room temperature, which is considerably higher compared to conventionally used isotropic graphite and C/C composite, and have sufficiently large thermal shock resistance as well. Thermal conductivity of the investigated isotropic graphite has also been improved up to 150 - 180 W/mK at room temperature. Finally, a few grades of 2-D felt type C/C composite with high thermal conductivity have been selected for the divertor plate material. As for the first wall material, two grades of isotropic graphite with higher thermal conductivity have been selected as well as one which has been used successfully in the JT-60 operation. (author).

52507 (JAERI-M–90-123) **Central MHD activities and role of the q=1 rational surface for pellet fuelled JT-60 plasmas.** Kamada, Yutaka (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Ozeki, Takahisa; Azumi, Masafumi; Yoshino, Ryuji; Nagami, Masayuki; Konoshima, Shigeru. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1990. 59p. Order Number DE91713083. Source: NTIS (US Sales Only), PC A04/MF A01.

Improved energy confinement for the pellet fuelled plasmas on JT-60 is mainly due to the peaked density and pressure profiles inside the q=1 rational surface, where the confinement characteristics appear to be better than those in the outer (q>1) region. In the well-center-fuelled pellet injection discharges, the sawtooth activity can be suppressed completely during 0.4≈1 sec or the frequency of sawtooth is reduced by up to one order of magnitude during 0.5≈1.5 sec after the pellet injection. For high high-current low-q (Ip = 2.5≈3.1 MA; q(a) < 3) discharges, reduction in the sawtooth frequency has a strong relationship with enhanced confinement and peakedness of the electron density profile. The contribution of the sawtooth activity to the global energy confinement increases systematically with decreasing q(a). At the sawtooth emerging after the pellet injection into high-Ip limiter discharges, only small amount of the central kinetic energy is released and the sawtooth does not follow the fully reconnecting style. The release of the central kinetic energy and the existence of precursor and successor m = 1 oscillations are discussed. The sawtooth crash tends to have more ideal-like characteristics for higher beta values and lower safety factors. The rotation velocity of the central plasma column after the pellet injection is also discussed with the frequencies of the m = 1 oscillations. Just after the pellet injection, the plasma

column starts to rotate in the ion-diamagnetic direction or the co-direction to the plasma current. At each sawtooth, the rotation frequency changes suddenly to the ion-diamagnetic direction or the co-direction. (author) 47 refs. 44 figs.

52508 (LA–11826-MS) **Target physics results at 248 nm wavelength from the Aurora laser system high-intensity campaign.** Watt, R.G.; Cobble, J.; Gomez, C.; Kephart, J.; Kristal, R.; Turner, T.P.; Oertel, J.; Thomas, S.; Netz, D.; Jones, J. Los Alamos National Lab., NM (USA). Oct 1990. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE91000887. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Au and Si targets have been irradiated using the Aurora KrF laser system, and diagnosed with x-ray and optical diagnostics. The x-ray diagnostics were sensitive to the 0.1–10 keV range. Initial, manually aligned results indicate significant plasma heating and intense x-ray production, with incident peak intensities on target of $1 - 2 \times 10^{14}$ W/cm^2 in a focal spot of order 500 μm diameter. Total energy delivered to the target in 36 of the available 48 target beams was approximately 1200 J in pulses with FWHM in the 3–5 ns range. M-band radiation was observed from Au foil targets. Initial bandwidth measurements on the laser indicate $\approx$20 cm^{-1} without bandwidth enhancement efforts.

52509 (LA-UR–90-2938) **ZTI: An ignition class reversed-field pinch.** Bathke, C.G.; Krakowski, R.A.; Miller, R.L.; Werley, K.A. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900918–9: 16. symposium on fusion technology, London (UK), 3-7 Sep 1990). Order Number DE91000447. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A cost-optimized conceptual design of an intermediate-step, ignition-class RFP device (ZTI)for the study of alpha-particle physics and burn control in a DT plasma is reported. With major and minor plasma radii R_T = 2.4m and τ_p = 0.4m, respectively, and for conservative extrapolations of experimental energy-confinement times, ion-density profiles, and impurity levels, the ZTI operating conditions during a 5-s period of constant fusion power are: toroidal plasma current $I_\phi \simeq 9$ MA, plasma temperature $T \simeq 11$ keV, plasma density $n_i \simeq 3 \times 10^{20}$ m^{-3}, fusion power $P_F \simeq 100$ MW, and physics Q-value $Q_p \simeq 5$ for a total machine size that corresponds to $P_F/M_{FPC} \simeq 590$ kW/tonne. This physics design point was adopted as a "strawman" with which to examine the requirements of ohmic heating to DT ignition and to perform a cost-optimized magnetics design. The ZTI design reflects potentially significant cost savings relative to similar ignition-class tokamaks for device parameters that reside on the path to a viable commercial RFP reactor. The methodology and results of coupling realistic physics, engineering, and cost models through a multi-dimensional optimizer are reported for this device that would follow the 2-4 MA ZTH presently under construction.

52510 (LA-UR–90-2974) **50 kA, 50 kV DC international and switching systems for the Los Alamos ZTH experiment.** Reass, W.A.; Cordova, R.J.; Garcia, J.G. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900918–8: 16. symposium on fusion technology, London (UK), 3-7 Sep 1990). Order Number DE91000442. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Los Alamos National Laboratory has completed the engineering design and development for the high power electrical switching networks for the ZTH experiment. ZTH is Reversed Field Pinch (RFP) plasma experiment with a 4 MA plasma current capability. Power to the ohmic heating (OH), equilibrium field (EF), and toroidal field (TF) coils will be provided from a 1.43 GVA turbo-alternator, which has over 600 MJ of extractable energy. The DC interrupting switch will handle 2.4 GVA, 150 MJ during initial machine operations. An additional 150 to 200 MJ are required for flat-topping the plasma current. A new ultra-high power switch, designed and tested at Los Alamos, will be used to reconfigure the power supply connections so that the supplies can be switched from parallel to series operation. In this manner, the same supplies can be used to charge and then flat-top the OH coils. The inexpensive cost of these switches results in significant economy of power supplies and systems. Detailed engineering information will be presented for the family of 25 kA and 50 kA, 50kV fast isolation and transfer switches, including testing of special water-cooled units capable of 50,000 amperes continuous duty. Similarly, detailed engineering data will be provided for the 150 MJ, 50 kA, 50kV DC interrupting system. This includes information on I_2t heating losses, contact resistance, long recovery time voltage standoff testing, and other pertinent engineering parameters. 6 refs., 12 figs.

52511 (LA-UR–90-3246) **Continued studies of co-pumping of deuterium and helium on a single, 4K activated charcoal panel.** Walthers, C.R. (Los Alamos National Lab., NM (USA)); Jenkins, E.M.; Batzer, T.H.; Sedgley, D.W.; Konishi, S.; Ohira, S.; Naruse, Y. Los Alamos National Lab., NM (USA). Sep 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-901007–3: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000218. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The short program undertaken in 1989 to evaluate the feasibility of co-pumping deuterium and tritium (DT) and helium on a charcoal sorbent showed that the charcoal will indeed simultaneously pump the gases. Of interest also was the fact that the total accumulation of helium (capacity) was virtually identical in constant throughput runs in which the D_2/He ratio was changed between runs. The test program described in this paper undertaken to evaluate further the co-pumping capabilities of the charcoal sorbent.

52512 (LA-UR–90-3261) **Tritium experiments on components for fusion fuel processing at the Tritium Systems Test Assembly.** Konishi, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan)); Yoshida, H.; Naruse, Y.; Carlson, R.V.; Binning, K.E.; Bartlit, J.R.; Anderson, J.L. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-901007–4: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000213. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Under a collaborative agreement between US and Japan, two tritium processing components, a palladium diffuser and a ceramic electrolysis cell have been tested with tritium for application to a Fuel Cleanup System (FCU) for plasma exhaust processing at the Los Alamos National Laboratory. The fundamental characteristics, compatibility with tritium, impurities effects with tritium, and long-term behavior of the components, were studied over a three year period. Based on these studies, an integrated process loop, "JAERI Fuel Cleanup System" equipped with above components was installed at the TSTA for full scale demonstration of the plasma exhaust reprocessing.

52513 (LA-UR–90-3331) **Accelerator-driven neutron sources for materials research.** Jameson, R.A. Los Alamos National Lab., NM (USA). [1990]. 17p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. DOE Contract W-7405-ENG-36. (CONF-901116–3: 11. international conference on the application of accelerators in research and industry, Denton, TX (USA), 5-8 Nov 1990). Order Number DE91000181. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Particle accelerators are important tools for materials research and production. Advances in high-intensity linear accelerator technology make it possible to consider enhanced neutron sources for fusion material studies or as a source of spallation neutrons. Energy variability, uniformity of target dose distribution, target bombardment from multiple directions, time-scheduled dose patterns, and other features can be provided, opening new experimental opportunities. New designs have also been used to ensure hands-on maintenance on the accelerator in these factory-type facilities. Designs suitable for proposals such as the Japanese Energy-Selective Intense Neutron Source, and the international Fusion Materials Irradiation Facility are discussed.

52514 (NIFS-TECH–1) **Runaway-electron-materials interaction studies.** Bolt, H.; Miyahara, A. National Inst. for Fusion Science, Nagoya (Japan). Mar 1990. 174p. Order Number DE91713080. Source: NTIS (US Sales Only), PC A08/MF A01.

During the operation of magnetic fusion devices it has been frequently observed that runaway electrons can cause severe damage to plasma facing components. The energy of the runaway electrons could possibly reach several 100 MeV in a next generation device with an energy content in the plasma in the order of 100 MJ. In this study effects of high energy electron - materials interaction were determined by laboratory experiments using particle beam facilities, i.e. the Electron Linear Accelerator of the Institute of Scientific and Industrial Research of Osaka University and the 10 MW Neutral Beam Injection Test Stand of the National Institute for Fusion Science. The experiments and further analyses lead to a first assessment of the damage thresholds of plasma facing materials and components under runaway electron impact. It was found that metals (stainless steel, molybdenum, tungsten) showed grain growth, crack formation and/or melting already below the threshold for crack initiation on graphite (14-33 MJ/m^2). Strong erosion of carbon materials would occur above 100 MJ/m^2. Damage to metal coolant channels can occur already below an energy deposition of 100 MJ/m^2. The energy deposited in the metal coolant channels depends on the thickness of the plasma facing carbon material D, with the shielding efficiency S of carbon approximately as $S \approx D^{1.15}$. (author) 304 refs. 12 tabs. 59 figs.

52515 (ORNL/FTR–3745) **[Lead-lithium corrosion and chemistry]: Foreign trip report, August 27–September 7, 1990.** Tortorelli, P.F. Oak Ridge National Lab., TN (USA). 21 Sep 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000381. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the 1990 European Workshop on Lead-Lithium Corrosion and Chemistry. Main areas of emphasis in the European liquid metal (exclusively Pb-17 at. % Li) program are now on deposition effects and corrosion-resistant surface product layers that can also serve as barriers to tritium permeation and insulators. Dr. Tortorelli also visited Harwell Laboratory to discuss innovative methods of corrosion analysis. He attended the 16th Symposium on Fusion Technology in London and the initial meeting of the Program Committee for the Second International Symposium on Fusion Nuclear Technology, which will be held in June 1991. He toured the JET facilities as part of the SOFT program.

52516 (PNL-SA–18521) **Measurements of activation cross sections for fusion reactor applications.** Greenwood, L.R. (Pacific Northwest Lab., Richland, WA (USA)); Bowers, D.L. Pacific Northwest Lab., Richland, WA (USA). Aug 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-900814–14: 7. ASTM-EURATOM symposium on reactor dosimetry, Strasbourg (France), 27-31 Aug 1990). Order Number DE91000155. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Neutron activation cross section data are needed for fusion reactor materials to facilitate neutron dosimetry and to determine activity levels for waste disposal, safety, and reactor maintenance applications. Measurements are reviewed for 36 different reactions, many leading to long-lived nuclides. Irradiations were performed at 14 MeV at the RTNS II to fluences of 10^{18} n/cm^2. Activities were determined by either gamma and x-ray analysis or liquid scintillation counting following radiochemical separations to remove interfering activities. Results are compared to calculations with the ALICE computer code. Activity levels are predicted for the STARFIRE fusion reactor design and compared to previous estimates. Other work is summarized including rare earth irradiations in Be(d,n), H(t,n), and T(d,n) accelerator-based neutron sources with average energies of 3, 10, and 14 MeV, respectively.

52517 (PPPL–2681) **Cold fusion catalyzed by muons and electrons.** Kulsrud, R.M. Pacific Northwest Lab., Richland, WA (USA). Oct 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE91000487. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two alternative methods have been suggested to produce fusion power at low temperature. The first, muon catalyzed fusion or MCF, uses muons to spontaneousiy catalyze fusion through the muon mesomolecule formation. Unfortunately, this method fails to generate enough fusion energy to supply the muons, by a factor of about ten. The physics of MCF is discussed, and a possible approach to increasing the number of MCF fusions generated by each muon is mentioned. The second method, which has become known as "Cold Fusion," involves catalysis by electrons in electrolytic cells. The physics of this process, if it exists, is more mysterious than MCF. However, it now appears to be an artifact, the claims for its reality resting largely on experimental errors occurring in rather delicate experiments. However, a very low level of such fusion claimed by Jones may be real. Experiments in cold fusion will also be discussed.

52518 (UCLA/PPG–1135, pp. 15, Paper 1) **Overview of the TITAN-I fusion-power core.** Grotz, S.P. (Univ. of California, Los Angeles (USA)); Ghoniem, N.M. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

The TITAN reactor is a compact (major radius of 3.9m and plasma minor radius of 0.6m), high neutron wall loading (~18 MW/m^2) fusion energy system based on the reversed-field pinch (RFP) confinement concept. The reactor thermal power is 2,918 MWt resulting in net electric output of 960 MWe and a mass power density of 700 kWe/tonne. The TITAN-I fusion power core (FPC) is a lithium, self-cooled design with vanadium alloy (V-3Ti-1Si) structural material. The surface heat flux incident on the first wall is ~4.5 MW/m^2. The magnetic field topology of the RFP is favorable for liquid metal cooling. In the TITAN-I design, the first wall and blanket consist of single pass, poloidal flow loops aligned with the dominant poloidal magnetic field. A unique feature of the TITAN-I design is the use of the integrated-blanket-coil (IBC) concept. With the IBC concept the poloidal flow lithium circuit is also the electrical conductor of the toroidal-field and divertor coils. Three dimensional neutronics analysis yields a tritium breeding ratio of 1.18 and a molten salt extraction technique is employed for the tritium extraction system. Almost every FPC component would qualify for Class C waste disposal. The compactness of the design allows the use of single-piece maintenance of the FPC. This maintenance procedure is expected to increase the plant availability. The entire FPC operates inside a vacuum tank, which is surrounded by an atmosphere of inert argon gas to impede the flow of air in the system in case of an accident. The top-side coolant supply and return virtually eliminate the possibility of a complete LOCA occurring in the FPC. The peak temperature during a LOFA is 991°C. 9 refs., 2 figs., 1 tab.

52519 (UCLA/PPG–1135, pp. 16, Paper 2) **Overview of the TITAN-II Reversed-Field Pinch aqueous fusion power core design.** Wong, C.P.C. (General Atomics Technologies Inc., San Diego, CA (USA)); Creedon, R.L.; Cheng, E.T.; Grotz, S.P.; Sharafat, S.; Cooke, P.I.H. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

TITAN-II is a compact, high power density Reversed-Field Pinch fusion power reactor design based on the aqueous lithium solution fusion power core concept. The selected breeding and structural materials are $LiNO_3$ and 9-C low activation ferritic steel, respectively. TITAN-II is a viable alternative to the TITAN-I lithium self-cooled design for the Reversed-Field Pinch reactor to operate at a neutron wall loading of 18 MW/m^2. Submerging the complete fusion power core and the primary loop in a large pool of cool water will minimize the probability of radioactivity release. Since the protection of the large pool integrity is the only requirement for the protection of the public, TITAN-II is a level 2 of passive safety assurance design. 13 refs., 4 figs., 1 tab.

52520 (UCLA/PPG–1135, pp. 16, Paper 3) **The safety designs for the TITAN reversed-field pinch reactor study.** Wong, C.P.C. (General Atomics Technologies Inc., San Diego, CA (USA)); Cheng, E.T.; Creedon, R.L.; Hoot, C.G.; Schultz, K.R.; Grotz, S.P.; Blanchard, J.P.; Sharafat, S.; Najmabadi, F. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

TITAN is a study to investigate the potential of the reversed-field pinch concept as a compact, high-power density energy system. Two reactor concepts were developed, a self-cooled lithium design with vanadium structure and an aqueous solution loop-in-pool design, both operating at 18 MW/m^2. The key safety features of the TITAN-I lithium-vanadium blanket design are in material selection, fusion power core configuration selection, lithium piping connections and passive lithium drain tank system. Based on these safety features and results from accident evaluation, TITAN-I can at least be rated as level 3 of safety assurance. For the TITAN-II aqueous loop-in-pool design, the key passive feature is the complete submersion of the fusion power core and the corresponding primary coolant loop system into a pool of low temperature water. Based on this key safety design feature, the TITAN-II design can be rated as level 2 of safety assurance. 7 refs., 2 figs.

52521 (UCLA/PPG–1135, pp. 20, Paper 4) **Activation and waste disposal of the TITAN RFP [reversed-field-pinch] reactors.** Cheng, E.T. (General Atomics Technologies Inc., San Diego, CA (USA)); Conn, R.W. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

The TITAN-I lithium self-cooled and TITAN-II aqueous lithium nitrate solution-cooled fusion reactors are based on the reversed-field-pinch (RFP) toroidal confinement concept and operate at high power density with an 18.1 MW/m^2 neutron wall loading. These designs were analyzed to study the activation and waste disposal aspects of such high-power density reactors. It was found that because of the use of V-3Ti-1Si (TITAN-I) and reduced activation ferritic steel (TITAN-II) as structural alloys for the first wall, blanket, reflector, and shield components, all the TITAN components except the divertor collector plates can be classified as shallow-land burial (10CFR61 Class C or better) nuclear waste for disposal, provided that the impurity elements, niobium and molybdenum, can be controlled below about 1 and 0.3 appm levels, respectively. The average annual disposal masses were estimated to be 150 and 96 tonnes, respectively, for the 1,000 MW TITAN-I and TITAN-II reactors. This corresponds to about 11% of the total mass in the fusion power core of both reactors. The divertor collector plates are fabricated with tungsten because of its low particle sputtering properties. These divertor collector plates in the TITAN-I reactor will be qualified as Class C waste after 18.1 MW-y/m^2 operation. The waste disposal rating of the divertor collector plates in the TITAN-II reactor, however, is estimated to be a factor of 4 higher than allowed for Class C disposal, because of the soft neutron spectrum in the beryllium environment. The annual disposal mass of this non-Class C waste is 0.35 tons, about 0.04% of the average annual discharge mass for the TITAN-II reactor. An additional 74 m^3 annual discharge of Class C waste containing ^{14}C may be needed for the TITAN-II reactor because of the use of nitrate salt in the aqueous coolant as the tritium breeder. 13 refs., 6 tabs.

52522 (UCLA/PPG–1135, pp. 17, Paper 5) **Maintenance procedures for the TITAN-I and TITAN-II reversed field pinch reactors.** Grotz, S.P. (Univ. of California, Los Angeles (USA)); Cooke, P.I.H.; Najmabadi, F.; Creedon, R.L.; Wong, C.P.C.; Duggan, W.; Krakowski, R. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

The TITAN reactor is a compact, high-power-density (neutron wall loading 18 MW/m^2) machine, based on the reversed-field-pinch (RFP) confinement concept. Two designs for the fusion power core have been examined; TITAN-I uses a self-cooled lithium loop with a vanadium-alloy structure for the first wall, blanket and shield, and TITAN-II is based on an aqueous loop-in-pool design with a $LiNO_3$ solution as the coolant and breeder. The compact design of the TITAN fusion power cores (FPCs) reduces the system to a few small and relatively low mass components, making toroidal segmentation of the FPC unnecessary. A single-piece maintenance procedure is possible. The potential advantages of single-piece maintenance procedures are: (1) shortest period of down time resulting from scheduled and unscheduled FPC repairs, (2) improved reliability resulting from integrated FPC pretesting in an on-site, non-nuclear test facility where coolant leaks, coil alignment, thermal expansion effects, etc., would be corrected prior to committing to nuclear service using rapid, and inexpensive, hands-on repair procedures, (3) no adverse effects resulting from the interaction of new materials operating in parallel to radiation damaged materials, and (4) ability to continually modify the FPC design as may be indicated by rector performance and technological developments. Increased availability can be expected from a fully pre-tested, single-piece FPC. Pre-testing of the FPC throughout the assembly process and prior to installation into the reactor vault is discussed. 6 refs., 4 figs., 4 tabs.

52523 (UCLA/PPG–1135, pp. 17, Paper 6) **Material selection for the TITAN reversed-field pinch reactor.** Sharafat, S. (Univ. of California, Los Angeles (USA)); Ghoniem, N.M.; Cooke, P.I.H. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

The operating conditions of a compact, high neutron wall loading fusion reactor severely limit the choices for structural, shield, insulator and breeder materials. In particular the response of plasma-facing materials to radiation, thermal and pressure stresses, and their compatibility with coolants are of primary concern. Material selection issues were investigated for the compact, high mass power density TITAN reactor design study. In this paper the major findings regarding material performance are summarized. The retention of mechanical strength at relatively high temperatures, low thermal stresses, and compatibility with liquid lithium make vanadium-base alloys a promising material for structural components. The thermal creep behavior of V-3Ti-1Si and V-15Cr-5Ti alloys has been approximately. In addition, irradiation behavior including the effects of helium generation and coolant compatibility issues were investigated which led to the choice of V-3Ti-1Si as the primary structural material candidate for the liquid lithium cooled TITAN-I. For the water-cooled TITAN-II reactor, ferritic alloys are favored among structural material candidates. Depending on the choice of lithium salt dissolved in water, the radiolytic effects and corrosion characteristics of the aqueous breeding solution may be severe. LiOH and $LiNO_3$ have been identified as the most viable salts, however, radiolytic and corrosion behavior of these salts in aqueous solutions differ substantially. Insulator material issues of concern include irradiation induced swelling and radiation induced conductivity. Both issues have been investigated and operating temperatures for minimum swelling and dielectric breakdown strength have been identified for spinel ($MgO \cdot Al_2O_3$). The high heat flux and sputtering/erosion issues limit the choice of the materials for the divertor target plate. 18 refs., 2 figs., 2 tabs.

52524 (UCLA/PPG–1135, pp. 16, Paper 7) **Thermal-hydraulic and structural design for the lithium-cooled TITAN-I reversed-field-pinch reactor.** Hasan, M.Z. (Univ. of California, Los Angeles (USA)); Blanchard, J.P.; Ghoniem, N.M. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

A thermal-hydraulic and structural design of the first wall and blanket for the 18 MW/m^2 neutron wall-loading TITAN reversed-field-pinch fusion reactor is presented. The primary coolant is liquid lithium and the structural material is the vanadium alloy, V-3Ti-1Si. Various design limits, which take the operational environment into consideration, for this vanadium alloy for the first wall and blanket are discussed. The first wall is made of small-diameter tubes. The blanket coolant channels are a combination of tubular, square, and rectangular channels. The first-wall and blanket coolant circuits are separate, allowing different coolant exit temperatures. The coolant channels are aligned with the larger poloidal magnetic field to reduce magnetohydrodynamic (MHD) pressure drops. At the design heat flux of 4.6 MW/m^2 on the first wall, MHD turbulent-flow heat transfer is used. Both the separation of the coolant circuits and the use of MHD turbulent-flow heat transfer substantially increase the heat flux limit on the first wall. These are favorable for high-power-density fusion reactors. The inlet temperature of lithium is 320°C and the exit temperatures are 440°C and 700°C for the first wall and blanket, respectively. The pressure drop in the first wall circuit is 10 MPa and is less than 3 MPa for the blanket circuit. The pumping power is less than 5% of electric output. The maximum structure temperature is less than 750°C and the material stresses are shown to be within the allowable limits. One-dimensional thermal and stress analyses are adequate for the thermal-hydraulic and structural design for TITAN-I. This is verified by two-dimensional, finite element analysis. 17 refs., 4 figs., 1 tab.

52525 (UCLA/PPG–1135, pp. 16, Paper 8) **A optimum Rankine power cycle for the lithium-cooled TITAN-I reversed-field-pinch reactor.** Hasan, M.. (Univ. of California, Los Angeles (USA)); Sze, D.K. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

A thermal power cycle for the TITAN-I fusion reactor is presented. The TITAN is a compact, high-power-density (neutron wall loading 18 MW/m^2) reactor based on the reversed-field pinch (RFP) confinement concept. The TITAN-I incorporates a fusion power core design with liquid-lithium as the coolant and breeder and vanadium alloy (V-3Ti-1Si) as the structural material. The total thermal power of TITAN-I is 2,918 MW$_t$. Of this total thermal power, 736 MW$_t$ is removed by the first-wall coolant, 29 MW$_t$ by the divertor coolant and the rest 2,153 MW$_t$ by the blanket coolant. The primary coolant inlet temperature is 320°C. The exit temperatures are 440°C, 540°C and 700°C for the first-wall, divertor and blanket coolants, respectively. Coolants from the first wall and divertor are mixed upon exit which gives the first-wall/divertor mixed exit temperature of 442°C. The blanket coolant is kept separate. The coolant flow rates in the first-wall, divertor and blanket circuits are 1,464, 31 and 1,350 Kg/sec, respectively. Liquid-lithium is also chosen as the secondary coolant in the intermediate heat exchangers. Several power-cycle modifications are considered. The selected power cycle has two components-one for the conversion of the thermal power in the first wall and divertor coolants, and the other for conversion of the thermal power in the blanket coolant which is at much higher thermal potential. The power cycle for the first wall and divertor is a non-reheat, superheat Rankine cycle with 4 stages of regenerative feed water heating. The pressure and temperature of the throttle steam are 1,500psia and 396°C, respectively. This results in a gross thermal efficiency of 37%. The power cycle for blanket is a Rankine cycle with 2-stage reheat and 7 stages of regenerative feed water heating. 10 refs., 4 figs., 2 tabs.

52526 (UCLA/PPG–1135, pp. 17, Paper 9) **Engineering design of the TITAN-II divertor.** Cooke, P.I.H. (Univ. of California, Los Angeles (USA)); Blanchard, J.P.; Grotz, S.P.; Hasan, M.Z.; Sharafat, S.; Bathke, C.G. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

The design of the toroidal-field divertor for the TITAN-II reversed-field-pinch reactor is described. Strong radiation from the core and edge plasma spreads the heat load over the first wall and divertor areas of the high-power-density reactor, and careful shaping of the divertor target plate restricts the maximum heat flux to ~7.5 MW/m^2. A further feature leading to manageable heat fluxes is the open configuration for the divertor, in which the target plate is located close to the null point to take advantage of the expansion of magnetic flux. The divertor target is constructed from a single material, a tungsten-rhenium alloy, for both the armor and coolant tubes, to avoid stress concentrations which arise at the interface between different materials. This alloy was chosen for its high ductility and good thermal and mechanical properties, which are retained at high temperatures, and for its excellent resistance to erosion by sputtering in the anticipated divertor plasma conditions. Detailed finite-element modeling of the divertor target indicates a peak equivalent thermal stress in the armor of ~500 MPa. Fabrication of the divertor plate is based on brazing the bank of coolant tubes to the armor, all components being manufactured using powder metallurgy techniques. The coolant for the divertor plate is an aqueous $LiNO_3$ solution, with a lithium atomic percentage of 6.4%, as used throughout the fusion power core. Consideration of the thermal and physical properties of this solution allows coolant conditions to be chosen such that an adequate safety margin for critical heat flux is provided. 10 refs., 5 figs.

52527 (UCLA/PPG–1135, pp. 19, Paper 10) **Properties of concentrated aqueous lithium nitrate solutions and applications to fusion reactor design.** Cooke, P.I.H. (Univ. of California, Los Angeles (USA)); Grotz, S.P.; Hasan, M.Z.; Martin, R.; Sharafat, S.; Sze, D.K.; Wong, C.P.C. California Univ., Los Angeles, CA (USA); GA Technologies, Inc., San Diego, CA (USA); Los Alamos National Lab., NM (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. Mar 1988. (CONF-880417–Pt.2: 1. international symposium on fusion nuclear technology (ISFNT), Tokyo (Japan), 10-19 Apr 1988). In *The TITAN Reversed-Field Pinch fusion reactor study. Collection of papers.* 174p. Order Number DE90001808. Source: NTIS, PC A08/MF A01.

Aqueous solutions of Li-containing compounds have been proposed to serve as the combined tritium breeding material and coolant for fusion reactors. The salt used for the TITAN-II reversed-field-pinch reactor design is $LiNO_3$, which was chosen for its good neutronics properties, relatively good corrosion characteristics, and for its high solubility in water. An extensive literature survey has shown that the physical and thermal properties of high-temperature, concentrated aqueous $LiNO_3$ solutions are markedly different from the pure water properties at similar conditions. These changes alter the heat transfer performance of the coolant, and the critical heat flux is estimated to rise for sub-cooled flow boiling, while the heat transfer coefficient for forced convection falls. Another important result is the elevation in boiling point, which may allow the operating pressure of the primary coolant to be reduced to a value below that of the secondary steam circuit, preventing leakage of the tritiated coolant into the steam circuit. Further research is needed into corrosion and radiolysis issues, but the available data imply that careful control of the coolant chemistry can minimize the problems. 26 refs., 5 figs.

52528 (UCRL–100531) **A model for the prediction of Nb_3Sn critical current as a function of field, temperature, strain, and radiation damage.** Summers, L.T.; Guinan, M.W.; Miller, J.R.; Hahn, P.A. Lawrence Livermore National Lab., CA (USA). 21 Sep 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900944–7: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000656. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Conductors designed for fusion machines must operate at high fields, under large mechanical loads, and in a high neutron flux. Present designs favor the use of Nb_3Sn with force-cooling by supercritical helium to extract large nuclear and ac loss heat loads. Consequently, the magnet designer must have a good knowledge of the critical current of the superconductor as a function of field, strain, temperature, and radiation damage. Expanding on work by Hampshire, et al. and Ekin, combined with radiation damage studies of Nb_3Sn, we express the critical field (B_{c20}) as function of temperature, strain and damage energy (E_d). Similarly, the zero-field critical temperature (T_{c0}) is expressed as a function of strain and damage energy. The expressions of B_{c20} and T_{c0} are combined into a functional form that allows an accurate and consistent estimate of the critical current density at the operating conditions of fusion magnet conductors. 9 refs., 4 figs.

52529 (UCRL–101648) **Laser driven instabilities in inertial confinement fusion.** Kruer, W.L. Lawrence Livermore National Lab., CA (USA). 4 Jun 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900264–9: Topical conference on research trends in nonlinear and relativistic effects in plasmas, San Diego, CA (USA), 5-8 Feb 1990). Order Number DE91000402. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Parametric instabilities excited by an intense electromagnetic wave in a plasma is a fundamental topic relevant to many applications. These applications include laser fusion, heating of magnetically-confined plasmas, ionospheric modification, and even particle acceleration for high energy physics. In laser fusion, these instabilities have proven to play an essential role in the choice of laser wavelength. Characterization and control of the instabilities is an ongoing priority in laser plasma experiments. Recent progress and some important trends will be discussed. 8 figs.

52530 (UCRL-CR–103908) **An approximate method for analyzing transient condensation on spray in HYLIFE-II.** Bai, R.Y. (California Univ., Berkeley, CA (USA). Dept. of Nuclear Engineering); Schrock, V.E. Lawrence Livermore National Lab., CA (USA); California Univ., Berkeley, CA (USA). Dept. of Nuclear Engineering. [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–12: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000947. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The HYLIFE-II conceptual design calls for analysis of highly transient condensation on droplets to achieve a rapidly decaying pressure field. Drops exposed to the required transient vapor pressure field are first heated by condensation but later begin to reevaporate after the vapor temperature falls below the drop surface temperature. An approximate method of analysis has been developed based on the assumption that the thermal resistance is concentrated in the liquid. The time dependent boundary condition is treated via the Duhamel integral for the pure conduction model. The resulting Nusselt number is enhanced to account for convection within the drop and then used to predict the drop mean temperature history. Many histories are considered to determine the spray rate necessary to achieve the required complete condensation.

52531 (UCRL-CR–103909) **The pressure relaxation of liquid jets after isochoric heating.** Chen, X.M. (California Univ., Berkeley, CA (USA). Dept. of Nuclear Engineering); Schrock, V.E. Lawrence Livermore National Lab., CA (USA); California Univ., Berkeley, CA (USA). Dept. of Nuclear Engineering. [1990]. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–11: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000946. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During isochoric heating by fast neutron irradiation, a high pressure is almost instantaneously built up inside the falling liquid jets in a HYLIFE (ICF) reactor. It has been suggested that the jets will breakup as a consequence of negative pressure occurring during the relaxation. This is important to both the subsequent condensation process and the chamber wall design. In this paper the mechanism of the relaxation of liquid jets after isochoric heating has been studied with both incompressible and compressible models. The transient pressure field predicted is qualitatively similar for both models and reveals a strongly peaked tension in the wake of a rarefaction wave. The pressure then rises monotonically in radius to zero pressure on the boundary. The incompressible approximation greatly over predicts the peak tension, which increases with time as the rarefaction wave moves toward the center of the jet. Since the tension distribution is as a narrow spike rather than uniform, a cylindrical fracture is the most likely mode of failure. The paper also discusses the available methods for estimating liquid tensile strength.

52532 (UCRL-CR–103910) **Pressure and impulse scaling methods for wall impact in ICF [inertial confinement fusion].** Liu, J.C. (California Univ., Berkeley, CA (USA). Dept. of Nuclear Engineering); Chen, X.M.; Schrock, V.E.; Orth, C.D. Lawrence Livermore National Lab., CA (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–14: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000949. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The design of the first structural wall (FSW) in an inertial confinement fusion (ICF) reactor requires some knowledge of the expected wall loading produced by x-ray and neutron deposition; specifically in the High Yield Lithium Injection Fusion Energy (HYLIFE) reactor, wall loading results from two sources – gas shock and liquid impact. Gas shock is derived from x-ray deposition in the thin layers of exposed blanket material, producing ionized vapor, which will generate gas shock on the FSW. Liquid impact, on the other hand, results from the acceleration of liquid blanket material by two possible forces – the drag from vapor expansion through the blanket material and the neutron-induced isochoric disassembly process. Both impacts, however, are coupled by the interaction of hot gas expanding through the liquid blanket. This paper discusses scaling methods for estimating pressure and impulse on the HYLIFE FSW from these impacts. In particular, this paper reviews simple analytical and numerical techniques, and the use of experimental results in the estimation of wall impacts for the HYLIFE blanket geometry. Considered important in the analyses are supersonic flow through jet arrays and isochoric disassembly. Given the same initial parameters as those used in previous HYLIFE studies, the techniques described here yield results comparable to the previous studies utilizing heavy numerical simulation.

52533 (UCRL-JC–101185) **A fuel pellet injector for the Microwave Tokamak Experiment (MTX).** Hibbs, S.M.; Allen, S.L.; Petersen, D.E.; Sewall, N.R. Lawrence Livermore National Lab., CA (USA). Sep 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-901035–3: 37. national American Vacuum Society symposium, Toronto (Canada), 8-12 Oct 1990). Order Number DE91000789. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Unlike other fueling systems for magnetically confined fusion plasmas, a pellet injector can deliver many fuel gas particles to the core of the plasma, enhancing plasma confinement. We installed a new pellet injector on the MTX (formerly Alcator-O) to provide a plasma with a high core density for experiments both with and without ultrahigh-power microwave heating. Its four-barrel pellet generator is the first to be designed and built at LLNL. Based on 'pipe-gun" technology originated at Oak Ridge National Laboratory (ORNL), it incorporates our structural and thermal engineering innovations and a unique control system. The pellet transport, differential vacuum-pumping stages, and fast-opening propellant valves are reused parts of the Impurity Study EXperiment (ISX) pellet injector built by ORNL. We tailored designs of all other systems and components to the MTX. Our injector launches pellets of

frozen hydrogen or deuterium into the MTX, either singly or in timed bursts of up to four pellets at velocities of up to 1000 m/s. Pellet diameters range from 1.02 to 2.08 mm. A diagnostic stage measures pellet velocities and allows us to photograph the pellets in flight. We are striving to improve the injector's performance, but its operations is already very consistent and reliable.

52534 (UCRL-JC–103285) **Design of a neutron penumbral-aperture microscope with 10-μm resolution.** Ress, D.; Lerche, R.A.; Ellis, R.J.; Lane, S.M. Lawrence Livermore National Lab., CA (USA). May 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900557–15: 8. topical conference on high-temperature plasma diagnostics, Hyannis, MA (USA), 6-10 May 1990). Order Number DE91000788. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We are currently designing a 10-μm resolution neutron penumbral-aperture microscope to diagnose high-convergence targets at the Nova laser facility. To achieve such high resolution, the new microscope will require substantial improvements in three areas. First, we have designed thick penumbral apertures with extremely sharp cutoffs over a useful ($\approx$100 μm) field of view; fabrication of such apertures appears feasible using gold electroplating techniques. Second, the limited field of view and required close proximity of the aperture to the target (2 cm) necessitates a durable mounting and alignment system with +25 μm accuracy. Finally, a neutron detector containing 160,000 scintillator elements is required; readout and optimization of this large array are outstanding issues. 5 refs., 3 figs.

52535 (UCRL-JC–103490) **A conceptual design of the International Thermonuclear Experimental Reactor for the Central Solenoid.** Heim, J.R.; Parker, J.M. Lawrence Livermore National Lab., CA (USA). 21 Sep 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900944–8: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000655. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Conceptual design of the International Thermonuclear Experimental Reactor (ITER) superconducting magnet system is nearing completion by the ITER Design Team, and one of the Central Solenoid (CS) designs is presented. The CS part of this magnet system will be a vertical stack of eight modules, approximately 16 m high, each having a approximate dimensions of: 4.1-m o.d., 2.8-m i.d., 1.9-m h. The peak field at the bore is approximately 13.5 T. Cable-in-conduit conductor with Nb_3Sn composite wire will be used to wind the coils. The overall coil fabrication will use the insulate-wind-react-impregnate method. Coil modules will be fabricated using double-pancake coils with all splice joints located in the low-field region on the outside of the coils. All coils will be structurally graded with high-strength steel reinforcement which is co-wound with the conductor. We describe details of the CS coil design and analysis.

52536 (UCRL-JC–103596) **FENIX [Fusion ENgineering International eXperimental]: A test facility for ITER [International Thermonuclear Experimental Reactor] and other new superconducting magnets.** Slack, D.S.; Patrick, R.E.; Miller, J.R. Lawrence Livermore National Lab., CA (USA). 21 Sep 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900944–9: Applied superconductivity conference, Aspen, CO (USA), 24-28 Sep 1990). Order Number DE91000654. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Fusion ENgineering International eXperimental (FENIX) Test Facility which is nearing completion at Lawrence Livermore National Laboratory, is a 76-t set of superconducting magnets housed in a 4-m-diameter cryostat. It represents a significant step toward meeting the testing needs for the development of superconductors appropriate for large-scale magnet applications such as the International Thermonuclear Experimental Reactor (ITER). The magnet set is configured to allow radial access to the 0.4-m-diameter high-field region where maximum fields up to 14 T will be provided. The facility is fitted with a thermally isolated test well with a port to the high-field region that allows insertion and removal of test conductors without disturbing the cryogenic environment of the magnets. It is expected that the facility will be made available to magnet developers internationally, and this paper discusses its general design features, its construction, and its capabilities.

52537 (UCRL-JC–103815) **Parametric cost analysis of a HYLIFE-II power plant.** Bieri, R.L. (Lawrence Livermore National Lab., CA (USA)). Lawrence Livermore National Lab., CA (USA). 4 Oct 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–10: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000945. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The SAFIRE (Systems Analysis for ICF Reactor Economics) code was adapted to model a power plant using a HYLIFE-II reactor chamber. The code was then used to examine the dependence of the plant capital costs and busbar cost of electricity (COE) on a variety of design parameters (type of driver, chamber repetition rate, and net electric power). The results show the most attractive operating space for each set of driver/target assumptions and quantify the benefits of improvements in key design parameters. The base case plant was a 1,000 MWe plant containing a reactor vessel driven by an induction linac heavy ion accelerator run at 7.3 Hz with a driver energy of 5 MJ and a target yield of 370 MJ. The total direct cost for this plant was 2,800 M$ (where all $ in this paper are 1988$s), and the COE was 9 ¢/KW*hour. The COE and total capital costs for the base plant assumptions for a 1,000 MWe plant are approximately independent of chosen repetition rate for all repetition rates between 4 and 10 Hz. For comparison, the COE for a coal or future fission plant would be 4.5–5.5 ¢/KW*hour. The COE for a 1,000 MWe plant could be reduced to 7.6 ¢/KW*hour by using advanced targets and could be cut to 6.8 ¢/KW*hour with conventional targets if the driver cost could be cut in half. There is a large economy of scale with heavy ion driven ICF plants; a 5,000 MWe plant with one heavy ion driver and either one or two HYLIFE-II chambers would have a COE of only 4.4 ¢/KW*hour.

52538 (UCRL-JC–103816) **HYLIFE-2 inertial confinement fusion reactor design.** Moir, R.W. Lawrence Livermore National Lab., CA (USA). 4 Oct 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–6: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000792. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The HYLIFE-II inertial fusion power plant design study uses a liquid fall, in the form of jets to protect the first structural wall from neutron damage, x-rays, and blast to provide a 30-y lifetime. HYLIFE-I used liquid lithium. HYLIFE-II avoids the fire hazard of lithium by using a molten salt composed of fluorine, lithium, and beryllium (Li_2BeF_4) called Flibe. Access for heavy-ion beams is provided. Calculations for assumed heavy-ion beam performance show a nominal gain of 70 at 5 MJ producing 350 MJ, about 5.2 times less yield than the 1.8 GJ from a driver energy of 4.5 MJ with gain of 400 for HYLIFE-I. The nominal 1 GWe of power can be maintained by increasing the repetition rate by a factor of about 5.2, from 1.5 to 8 Hz. A higher repetition rate requires faster re-establishment of the jets after a shot, which can be accomplished in part by decreasing the jet fall height and increasing the jet flow velocity. Multiple chambers may be required. In addition, although not considered for HYLIFE-I, there is undoubtedly liquid splash that must be forcibly cleared because gravity is too slow, especially at high repetition rates. Splash removal can be accomplished by either pulsed or oscillating jet flows. The cost of electricity is estimated to be 0.09$/kW·h in constant 1988 dollars, about twice that of future coal and light water reactor nuclear power. The driver beam cost is about one-half the total cost. 12 refs., 9 figs., 5 tabs.

52539 (UCRL-JC–103817) **Grazing incidence metal mirrors as the final elements in a laser driver for inertial confinement fusion.** Bieri, R.L.; Guinan, M.W. Lawrence Livermore National Lab., CA (USA). 4 Oct 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–9: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000944. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Grazing incidence metal mirrors (GIMMS) have been examined to replace dielectric mirrors for the final elements in a laser beam line for an inertial confinement fusion (ICF) reactor. For a laser driver using light with a wavelength from 250 to 500 nm in a 10 ns pulse, irradiated mirrors made of Al, Al alloys, or Mg were found to

have calculated laser damage limits of 0.3–2.3 J/cm^2 of beam energy and neutron lifetime fluence limits of over 5 x 10^{20} neutrons per square centimeter when use at grazing incidence (an angle of incidence of 85 degrees) and operated at room temperature or at 77 K. A final focusing system including mirrors made of Al alloy 7475 at room temperature or at liquid nitrogen (LN) temperatures used with a driver which delivers 5 MJ of beam energy in 32 beams would require 32 mirrors of roughly 10 m^2 each. This paper briefly reviews the methods used in calculating the damage limits for GIMMs and discusses critical issues relevant to the integrity and lifetime of such mirrors in a reactor environment. 9 refs.

52540 (UCRL-JC–103818) **Oscillating liquid flow ICF [inertial confinement fusion] reactor.** Petzoldt, R.W. Lawrence Livermore National Lab., CA (USA). 4 Oct 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–7: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000793. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Oscillating liquid flow in a falling molten salt inertial confinement fusion reactor is predicted to rapidly clear driver beam paths of residual molten salt. Oscillating flow will also provide adequate neutron and x-ray protection for the reactor structure with a short (2-m) fall distance permitting an 8 Hz repetition rate. A reactor chamber configuration is presented with specific features to clear the entire heavy-ion beam path of splashed molten salt. The structural components, including the structure between beam ports, are shielded. 3 refs., 12 figs.

52541 (UCRL-JC–103938) **The cascade ICF reactor with an x-ray and debris shield and a heavy-ion driver.** Pitts, J.H.; Tabak, M. Lawrence Livermore National Lab., CA (USA). 28 Sep 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-901007–5: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000791. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The use of a 1-kg solid-lithium x-ray and debris shield around each fusion fuel pellet prevents vaporization of, and destructive shock waves in, the Cascade blanket granules thereby increasing their lifetime. The shield vaporizes as it absorbs energy and the vapor flows into the blanket several centimeters. The shield also increases tritium breeding and enhances vacuum pumping of high Z materials that are vaporized in the fuel pellet. Using heavy ion beams allows illumination of the fuel pellets with the restricted geometry present in Cascade. We used a 5 MJ driver with 18 beams (one 3 x 3 array from each end).

52542 (UCRL-JC–104182) **Some applications of mirror-generated electric potentials to alternative fusion concepts.** Post, R.F. Lawrence Livermore National Lab., CA (USA). 24 Sep 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9010209–1: Workshop on physics of alternative magnetic confinement schemes, Varenna (Italy), 14-15 Oct 1990). Order Number DE91000973. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Transient electrical potentials can be generated in plasmas by utilizing impulsive mirror-generated forces acting on the plasma electrons together with ion inertia to cause momentary charge imbalance. In the Mirrortron such potentials are generated by applying a rapidly rising (tens of nanoseconds) localized mirror field to the central region of a hot-electron plasma confined between static mirrors. Because of the loss-cone nature of the electron distribution the sudden appearance of the pulsed mirror tends to expel electrons, whereas the ion density remains nearly constant. The quasi-neutrality condition then operates to create an electrical potential the equipotential surfaces of which can be shown theoretically to be congruent with surfaces of constant B. An alternative way of generating transient potentials is to apply a pulse of high-power microwaves to a plasma residing on a magnetic field with a longitudinal gradient. This technique resembles one employed in the Pleiade experiments. At gigawatt power levels, such as those produced by a Free Electron Laser, the production of very high transient potentials is predicted. Fusion-relevant applications of these ideas include heavy-ion drivers for inertial fusion, and the possibility of employing these techniques to enhance the longitudinal confinement of fusion plasmas in multiple-mirror systems. 23 refs., 3 figs.

52543 (UCRL-JC–104418) **Particle distributions in collisionless magnetic reconnection: An implicit Particle-In-Cell (PIC) description.** Hewett, D.W.; Francis, G.E.; Max, C.E. Lawrence Livermore National Lab., CA (USA). 29 Jun 1990. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006220–5: 28. COSPAR plenary conference, The Hague (Netherlands), 25 Jun - 6 jul 1990). Order Number DE91000404. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Evidence from magnetospheric and solar flare research supports the belief that collisionless magnetic reconnection can proceed on the Alfven-wave crossing timescale. Reconnection behavior that occurs this rapidly in collisionless plasmas is not well understood because underlying mechanisms depend on the details of the ion and electron distributions in the vicinity of the emerging X-points. We use the direct implicit Particle-In-Cell (PIC) code AVANTI to study the details of these distributions as they evolve in the self-consistent E and B fields of magnetic reconnection. We first consider a simple neutral sheet model. We observe rapid movement of the current-carrying electrons away from the emerging X-point. Later in time an oscillation of the trapped magnetic flux is found, superimposed upon continued linear growth due to plasma inflow at the ion sound speed. The addition of a current-aligned and a normal B field widen the scope of our studies.

52544 (UCRL-JC–104573) **ECH by FEL and gyrotron sources on the Microwave Tokamak Experiment (MTX) tokamak.** Stallard, B.W. (Lawrence Livermore National Lab., CA (USA)); Turner, W.C.; Allen, S.L.; Byers, J.A.; Felker, B.; Fenstermacher, M.E.; Ferguson, S.W.; Hooper, E.G.; Thomassen, K.I.; Throop, A.L.; Makowski, M.A. Lawrence Livermore National Lab., CA (USA). 9 Aug 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900918–6: 16. symposium on fusion technology, London (UK), 3-7 Sep 1990). Order Number DE91000286. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Microwave Tokamak Experiment (MTX) at LLNL is studying the physics of intense pulse ECH is a high-density tokamak plasma using a microwave FEL. Related technology development includes the FEL, a windowless quasi-optical transmission system, and other microwave components. Initial plasma experiments have been carried out at 140 GHz with single rf pulses generated using the ETA-II accelerator and the ELF wiggler. Peak power levels up to 0.2 GW and pulse durations up to 10 ns were achieved for injection into the plasma using as untapered wiggler. FEL pulses were transmitted over 33 m from the FEL to MTX using six mirrors mounted in a 50-cm-diam evacuated pipe. Measurements of the microwave beam and transmission through the plasma were carried out. For future rapid pulse experiments at high average power (4 GW peak power, 5kHz pulse rate, and $\bar{P} > 0.5$ MW) using the IMP wiggler with tapered magnetic field, a gyrotron (140 GHz, 400 kW cw or up to 1 MW short pulse) is being installed to drive the FEL input or to directly heat the tokamak plasma at full gyrotron power. Quasi-optic techniques will be used to couple the gyrotron power. For direct plasma heating, the gyrotron will couple into the existing mirror transport system. Using both sources of rf generation, experiments are planned to investigate intense pulse absorption and tokamak physics, such as the ECH of a pellet-fueled plasma and plasma control using localized heating. 12 refs., 9 figs.

52545 (UCRL-JC–104849) **Fusion energy: Progress in the design of the international thermonuclear experimental reactor (ITER).** Lawrence Livermore National Lab., CA (USA). Sep 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900608–Absts.: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE91000801. Source: NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The main purpose of the International Thermonuclear Experimental Reactor (ITER) is to develop an experimental fusion reactor through the united efforts of many technologically advanced countries. The ITER terms of reference, issued jointly by the European Community, Japan, the USSR, and the United States, call for an

integrated international design activity and constitute the basis of current activities. Joint work on ITER is carried out under the auspices of the International Atomic Energy Agency (IAEA), according to the terms of quadripartite agreement reached between the European Community, Japan, the USSR, and the United States. The site for joint technical work sessions is at the MaxPlanck Institute of Plasma Physics. Garching, Federal Republic of Germany. The ITER activities have two phases: a definition phase performed in 1988 and the present design phase (1989–1990). During the definition phase, a set of ITER technical characteristics and supporting research and development (R&D) activities were developed and reported. The present conceptual design phase of ITER lasts until the end of 1990. The objectives of this phase are to develop the design of ITER, perform a safety and environmental analysis, develop site requirements, define future R&D needs, and estimate cost, manpower, and schedule for construction and operation. A final report will be submitted at the end of 1990. This paper summarizes progress in the ITER program during the 1989 design phase.

52546 (UCRL-JC–105033) **The heat transport system and plant design for the HYLIFE-2 fusion reactor.** Hoffman, M.A. Lawrence Livermore National Lab., CA (USA). 21 Aug 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-901007–8: 9. topical meeting on technology of fusion energy, Oak Brook, IL (USA), 7-11 Oct 1990). Order Number DE91000787. Source: NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

HYLIFE is the name given to a family of self-healing liquid-wall reactor concepts for inertial confinement fusion. This HYLIFE-II concept employs the molten salt, Flibe, for the liquid jets instead of liquid lithium used in the original HYLIFE-I study. A preliminary conceptual design study of the heat transport system and the balance of plant of the HYLIFE-II fusion power plant is described in this paper with special emphasis on a scoping study to determine the best intermediate heat exchanger geometry and flow conditions for minimum cost of electricity. 11 refs., 8 figs.

52547 **Reconstruction of m = 1 MHD modes from projections.** Sauthoff, N.R. (Princeton Univ., NJ (USA)); McGuire, K.M.; Von Goeler, S. pp. N4 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper describes a method for the inversion of line integral data from a single-view of rotating plasma based on a harmonic decomposition of the poloidal structure. A simulation program generates sample data based on the assumption of a slowly-evolving plasma with a displaced central hot-spot and a plateau near the radius of the q = 1 surface. The sample data are decomposed into time windows to permit reconstructions are compared to the source data. Applicability to experimental tokamak data is discussed.

52548 **Use of graphite in Langmuir-calorimeter probe heads.** Kilpatrick, S. (Princeton Univ., NJ (USA)); Manos, D.; Ritter, R.; Stangeby, P. pp. K6 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

K6.

This paper discusses graphite which has become an important material in magnetically confined fusion devices, being used for components such as limiter blades, divertor plates and Faraday shields. Langmuir-calorimeter probes on TFTR and PLT have utilized ATJ graphite in probe heads, active elements, protective shields and in an epoxy compound for various applications. Most recently, all-graphite edge probes have been used successfully on these machines. The advantages and disadvantages of using this material as a collecting element and a heat resistant support are discussed, with reference to its survivability and usefulness in the TFTR environment. A two-dimensional finite-element thermal analysis of a TFTR graphite calorimeter is presented which calculates its temperature response to selected power inputs. This was used to estimate power densities a the edge of TFTR plasmas.

52549 **The TFTR Mirnov loop system.** Fredrickson, E. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Colchin, R.; McGuire, K; Sauthoff, N. pp. K11 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). pp. 92 (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper discusses magnetic pick-up loops (Mirnov coils) located on the inner wall of the TFTR vacuum vessel used to study magnetic fluctuations in the plasma. To study the high frequency magnetic turbulence associated with beam injection, the signal from one coil is passed through a comb filter, which gives a measure of the frequency spectrum throughout the shot. To look for tearing modes, the signals from a poloidal array of fifteen coils are summed in an analog system to give the amplitudes of the m = 2, m = 3 and m = 4 coherent modes throughout the shot. Twenty coil signals are digitized individually at a rate of 100kHz for 80 ms and at 10kHz for 800 ms. This data may be analyzed off line to get both the toroidal and poloidal mode numbers as well as frequency spectrum information for a limited portion of the discharge.

52550 **The moon: An abundant source of clean and safe fusion fuel for the 21st century.** Kulcinski, G.L. (Wisconsin Univ., Madison, WI (USA). Dept. of Nuclear Engineering and Engineering Physics); Schmitt, H.H. pp. 525-554 of Fueling the 21st century. Sheindlin, A.E.; Zaleski, P. Hemisphere Publishing, New York, NY (USA) (1989). pp. 860

This paper discusses the possibility of an inherently safe nuclear power source in the 21st century. The discovery of a large source of energy on the moon is described. Establishment of lunar bases is examined.

52551 **Comparison of four concepts for an inertial-confinement-fusion power plant.** Pitts, J.H. (Lawrence Livermore National Laboratory, CA (USA)); Bangerter, R.O.; Moir, R.W. *Transactions of the American Nuclear Society (USA)*, 59: 104-105 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Fusion has the potential to be a safe, clean and abundant energy source for producing electrical power in the next century-perhaps just as fossil fuel becomes scarce and its adverse environmental effects become significant. A program to develop concepts for inertial-confinement-fusion (ICF) power plants that produce electricity was initiated at the Lawrence Livermore National Laboratory ~10 yr ago. Studies have been completed on a number of ICF reactor concepts used in these power plants and are now evaluating two additional reactor concepts. Two of the concepts that have already been evaluated, HYLIFE and Cascade, are particularly attractive. This paper compares the advantages of HYLIFE and Cascade with the two reactors currently being evaluated. 3 refs.

52552 **Rejuvenation of CANDU [Canada deuterium uranium] spent fuel in a hybrid blanket.** Sahin, S. (Gazi Univ. (Turkey)); Yapici, H. *Transactions of the American Nuclear Society (USA)*, 59: 105-106 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The existing nuclear power plants can utilize only a small fraction of their fissile fuel. The possibility of the rejuvenation of spent nuclear fuel in a hybrid blanket is an attractive application field for early-generation fusion reactors. In the past, this option was investigated for light water reactor spent fuel. Little attention has been paid to the rejuvenation of spent Canada deuterium uranium (CANDU) fuel, although this type of rector has the lowest burnup rate per fuel mass, and consequently the highest ratio of spent-fuel mass/burnup. At present, there are many CANDU reactors in operation, and a substantial quantity of spent fuel is being stored without any clearly defined plans for future use. In this work, a hybrid blanket is investigated that contains CANDU spent fuel. The main objective is to study the rejuvenation behavior in a hybrid blanket coupled with substantial in situ electricity production. 12 refs., 2 figs., 1 tab.

52553 **Mixed-DT neutral-beam injection: An alternative heating method for tokamaks.** Ruby, L. (Univ. of California, Berkeley (USA)); Lewis, M.S. *Transactions of the American Nuclear Society*

(USA), 59: 107-108 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

In this paper, the authors propose an alternative method for the heating, and perhaps also refueling, of tokamak fusion devices. The alternative method replaces the deuterium neutral-beam injectors (NBIs) such as those now used, for example, on the Tokamak Fusion Test Reactor (TFTR) device. Instead they make use of a mixed (deuterium-tritium) NBI (MNBI) and thereby vastly reduce the cost and complexity of the fuel-recovery cycle. Another like consequence is the reduction of the total amount of tritium in the on-site inventory. The authors suspect that the alternative plant design would have a positive effect on safety, although they have not done an accident analysis based on the mixed-beam injectors. They have, however, studied the requirements of the new fuel cycle and have looked at the question of optimizing some of the parameters associated with a mixed-beam injector. 3 refs.

52554 Burn control studies for the International Thermonuclear Experimental Reactor. Mandrekas, J.; Stacey, W.M. *Transactions of the American Nuclear Society (USA)*, 59: 109-111 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The objective of the International Thermonuclear Experimental Reactor (ITER) is to demonstrate the scientific and technological feasibility of fusion power. In order to reach this objective, ITER would have to demonstrate controlled ignition and extended burn of deuterium-tritium (D-T) plasmas with steady state as an ultimate goal, as well as to validate design concepts and qualify engineering components that are essential to a reactor in an integrated system. It has long been known that tokamak reactors operating on the D-T cycle may be unstable against excursions in the particle temperature and density. This instability or thermal runaway is driven by the strong temperature dependence of the D-T reaction rate and can lead to disruptions due to violation of the beta limit or to operation in a regime incompatible with the engineering design of the reactor. Therefore, the identification and evaluation of different methods for burn control for ITER have been recognized recently to be as important an objective as any other major design requirement. Recent calculations for the compact ignition tokamak indicate that burn control via auxiliary power modulation is the most attractive method to be used in first-generation ignited fusion experiments. The purpose of this work is to evaluate auxiliary power modulation as a control mechanism for ITER.

52555 Impurity activation in magnet structural materials for fusion reactors. Zuchetti, M. *Transactions of the American Nuclear Society (USA)*, 59: 111-112 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Neutron-induced activity in fusion-reactor components can be effectively controlled through materials selection. This primarily applies to in-vessel components (first wall, blanket, etc.). However, some of the other machine components, such as the magnet coils, are also activated. In the Next European Torus (NET) project, for instance, activity in these components is high enough to require remote handling. The role of impurities in determining the activity in first-wall materials has already been investigated. In particular, it turns out that their medium- and long-term activity is remarkable affected by the presence of certain impurities. In order to satisfy currently proposed low-activity criteria, severe limitations have to be imposed on these impurities. In this paper, the authors examines the same problem in magnet structural materials. Specifically, the authors shall determine whether impurities can contribute a significant part of the activity in these materials. 5 refs., 2 tabs.

52556 An evaluation of brazes for plasma facing component applications from a waste disposal perspective. Parish, T.A. (Texas A & M Univ., College Station (USA)); Koski, J.A. *Transactions of the American Nuclear Society (USA)*, 59: 113-114 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Plasma facing components in fusion devices such as tokamaks must often sustain heat fluxes in the 2 to 40 MW/m^2 range. In this environment, it is essential that armor tiles be affixed to an actively cooled substrate with a minimum of thermal contact resistance. For divertor plates, limiters, beam dumps, and other high-heat-flux components used in fusion devices, low Z armor tiles, such as graphite, or high Z armor tiles, such as tungsten, are often brazed to cooled, highly conductive substrates, such as copper. The brazes that are typically 2 to 3 mils thick are chosen for certain characteristics, including (a) the ability to wet the materials to be joined, (b) braze time and temperature and consequent effects on material properties, and (c) metallurgical considerations, such as the potential formation of intermetallic alloys. The effect, or lack of effect, that the braze filler metal has on the granular structure of the metal substrate (copper) is also a consideration. Brazes will be needed in experimental fusion reactors in order to fasten armor tiles to substrates with minimal thermal contact resistance. Calculations of the activation products formed when candidate brazes are irradiated rule out the use of those containing significant amounts of silver or palladium according to current low-level-waste disposal limits. Some of the brazes that are most promising from a waste-disposal perspective have rather small engineering data bases on which to predicate their performance and may have less advantageous metallurgical characteristics. Investigations are continuing to identify promising armor tile-braze-substrate combinations. 3 refs., 1 tab.

52557 Performance of internally sealed IRF antennas in CCT. Taylor, R.J. (University of California at Los Angeles, Los Angeles, CA (USA)); Brown, M.L.; Lai, K.F.; Liberati, J.R. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 190(1): 358-361 (1 Jul 1989). DOE Contract FG03-86ER53225. (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

The internally sealed ICRF antennas in CCT no longer show impurity problems in the steady state or in the pulsed mode. Experience over a 6 month period indicates a minimum of one order of magnitude reduction in impurity generation for comparable input power (50 kW) used in previous experiments. The antenna radiation resistances agree with computer calculation within experimental error. In the Fast Wave Current Drive regime cavity resonances are absent. The power transfer to the plasma is nearly ideal. It is now clear that the power goes to the ions at the edge, where confinement is poor. The absorption mechanism is not understood. Wave penetration to the center is only possible for extremely low ($<10^{12} cm^3$) densities.

52558 The TFTR ICRF antenna-power feed and phase control of two mutually coupled antenna elements. Wilson, J.R. (Princeton Plasma Physics Laboratory, Princeton University, Princeton, NJ (USA)); Colestock, P.L.; Greene, G.J.; Hosea, J.C.; Phillips, C.K.; Stevens, J.E.; Hoffman, D.J.; Gardner, W.L. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 190(1): 370-373 (1 Jul 1989). DOE Contract AC02-76CH03073. (CONF-8905120--: 8. topical conference on radio frequency power in plasmas, Irvine, CA (USA), 1-3 May 1989).

A transmission line model for the TFTR ICRF antenna is presented. The antenna is considered as being composed of mutually coupled transmission lines. Expressions for the input impedance of such a structure are given. Details of the considerations in setting up the antenna feed structure are presented. The requirement of dual feed drive coupled with the desire for phase and amplitude control place restrictions on the operating circuit.

52559 On the use of atmospheric pressure plasmas as electromagnetic reflectors and absorbers. Vidmar, R.J. (SRI International, Menlo Park, CA (US)). *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA)*, 18(4): 733-741 (Aug 1990).

Tenuous plasmas in the earth's atmosphere from sea level to 100 km can be modeled as a cold collisional plasma. If an ionization process results in an electron density profile, such as an Epstein profile, that decreases from a maximum as a function of distance, then the plasma can either reflect or absorb electromagnetic waves, depending on the plasma characteristics. A high reflection coefficient requires a grazing angle of incidence, a low momentum-transfer collision rate, a high plasma density, and a short free-space-to-plasma transition relative to a wavelength. High absorption from VHF through X-band requires a high collision rate, a low plasma density, and a plasma transition of approximately

one wavelength. Both extremes are discussed. Typical collision rates and plasma lifetimes at atmospheric pressure are quantified.

99 GENERAL AND MISCELLANEOUS

52560 (BCC–CE03190) **Resource rich/development poor. An overview of forest products industries in Canada.** Boise Cascade Canada Ltd., Newcastle, NB (Canada). 1990. 92p. (CONF-9001116–: 22. annual Lakehead University Forestry Association forestry symposium, Thunder Bay (Canada), Jan 1990; CE–03190). Source: School of Education, Lakehead University, Thunder Bay, ON, CAN P7B 5E1. Prices: PRICES UPON REQUEST.

A symposium was held to discuss various issues related to the Canadian forest industry. Papers were presented on forest resources, the solid wood products industry, the pulp and paper industry, recycling in the pulp and paper industry, and pollution in the forest products industries. A separate abstract has been prepared for one paper from this symposium.

52561 (GKSS–90/E/1) **Scientific-technical reports of the GKSS 1989.** GKSS-Forschungszentrum Geesthacht GmbH, Hamburg (Germany, F.R.). 1990. 39p. (In German). Order Number DE91706219. Source: NTIS (US Sales Only), PC A03/MF A01.

The following review contains, arranged by the main fields of research, authors and titles of all external GKSS reports published in 1989. Abstracts and bibliographical data are presented with the exception of reprints form journal articles, proceedings papers, and contributions to monographs. A general index in numerical order is supplemented. (orig./HK).

9901 Management

Refer also to citation(s) 50988, 51879

52562 (CIM/PS–CE03173, pp. 36.1-36.8, Paper 88-39-36) **Prevention maintenance and plant turnaround scheduling.** Turner, D.G. (Delta Projects Inc. (Canada)). Petroleum Society of CIM (Canada). 1988. (CONF-8806494–: 39. annual technical meeting of the Petroleum Society of CIM and 2. quarterly meeting of 1988 of the Canadian Gas Processors Association, Calgary (Canada), 12-16 Jun 1988; CE–03173). In *Applied vision: Realizing our potential: Volume 1.* vp. Source: Petroleum Society of CIM, 320, 101-6th Avenue S.W., Calgary, AB, CAN T2P 3P4. Prices: PRICES UPON REQUEST.

A management and planning system has been developed for use in plant turnarounds, based on an analysis of 30 years of experience with major and minor turnaround activities. The basic concepts included in the resulting procedures used in turnaround organization and execution are outlined. These concepts include the generation of work lists prior to the turnaround start date, a review of the responsibilities of the planning group prior to and after the turnaround work list review meeting, the gathering of information needed prior to developing the turnaround schedule, development of the turnaround schedule, and the turnaround itself. The concepts were adapted to a computerized planning system called CASP (Computer Assisted Shutdown Planning) which is a specialized, portable, microcomputer-based tool that efficiently assigns to each item of site equipment involved in a turnaround of any site: manpower, tools, materials, and required permits at the activity or job step level. The CASP system is based on detailed critical path networking techniques and uses the discrete equipment item as its major key. It allows grouping of tasks that logistically belong together in separate networks, thus dividing the turnaround into a number of mini-turnarounds. Features of CASP include a generic equipment library containing typical work plans for various types and sizes of process equipment, capability to analyze various options, and provision of reports and cost estimates. CASP is in use at refineries, petrochemcial plants, and gas plants with benefits such as reduction in turnaround planning effort, reduced turnaround duration, and improved utilization of manpower, material, and resources.

52563 (EUR–12385) **Institute for transuranium elements Karlsruhe Annual Report 1988.** Commission of the European Communities, Luxembourg (Luxembourg). 1989. 239p. (TUAR–88). Source: NTIS (US Sales Only), PC A11/MF A01.

The present report summarizes the results of the work which has been performed in 1988 at the Institute for Transuranium Elements of the Joint Research Centre of the Commission of the European Communities. While, as in the past, major efforts were devoted to the Programme on Nuclear Fuels and Actinide Research, important contributions were made to other JRC Specific Programmes, i.e. Reactor Safety, Radioactive Waste Management, and Safeguards and Fissile Materials Control. In addition, The Institute has carried out analytical work for the EURATOM Safeguards Directorate and executed research tasks in the safeguards context, both, for the Commission of the European Communities and for the International Atomic Energy Agency in Vienna. Exploratory Research, finally, dealt with an investigation of possibilities of acoustic aerosol scavenging.

52564 (NUREG–0325-Rev.14) **US Nuclear Regulatory Commission functional organization charts: Revision 14.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Personnel. 15 Aug 1990. 62p. Sponsored by Nuclear Regulatory Commission. Source: NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

Functional organization charts for the US Nuclear Regulatory Commission offices, divisions, and branches are presented in this document.

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Refer also to citation(s) 50545, 50554, 50557, 50565, 50604, 50731, 50761, 50788, 50792, 50850, 50882, 50905, 50915, 50937, 50990, 51022, 51058, 51061, 51073, 51075, 51076, 51143, 51155, 51268, 51289, 51373, 51381, 51392, 51394, 51395, 51396, 51399, 51417, 51422, 51490, 51502, 51512, 51579, 51599, 51614, 51617, 51623, 51625, 51629, 51631, 51679, 51687, 51689, 51700, 51701, 51726, 51777, 51883, 51893, 51970, 52010, 52171, 52272, 52285, 52295, 52296, 52313, 52342, 52343, 52345, 52350, 52351, 52427, 52612, 52613, 52614

52565 (AD-A–223436/7/XAB) **Gamma data-base machine project. Technical report.** DeWitt, D.J.; Ghandeharizadeh, S.; Schneider, D.; Bricker, A.; Hsiao, H. Wisconsin Univ., Madison, WI (USA). Dept. of Computer Sciences. Mar 1990. 37p. Contract N00039-86-C-0578, Grant NSF-DCR85-12862. (TR–921). Source: NTIS, PC A03/MF A01.

This paper describes the design of the Gamma database machine and the techniques employed in its implementation. Gamma is a relational database machine currently operating on an Intel iPSC/2 hypercube with 32 processors and 32 disk drives. Gamma employs three key technical ideas which enable the architecture to be scaled to 100s of processors. First, all relations are horizontally partitioned across multiple disk drives enabling relations to be scanned in parallel. Second, novel parallel algorithms based on hashing are used to implement the complex relational operators such as join and aggregate functions. Third, dataflow scheduling techniques are used to coordinate multioperator queries. By using these techniques it is possible to control the execution of very complex queries with minimal coordination - a necessity for configurations involving a very large number of processors. In addition to describing the design of Gamma software, a thorough performance evaluation of the iPSC/2 hypercube version of Gamma is also presented. In addition to measuring the effect of relation size and indices on the response time for selection, join, aggregation, and update queries, we also analyze the performance of Gamma relative to the number of processors employed when the sizes of the input relations are kept constant (speedup) and when the sizes results obtained for both selection and join queries are linear; thus, doubling the number of processors halves the response time for a query.

52566 (AD-A–223479/7/XAB) **Parallel architectures and algorithms for image understanding. Final technical report, 1 November 1988-30 September 1989.** Nevatia, R.; Prasanna-Kumar, V.K. University of Southern California. Los Angeles, CA

(USA). Inst. for Robotics and Intelligent Systems. 17 May 1990. 45p. Grant AFOSR-89-0032. Source: NTIS, PC A03/MF A01.

Availability: Document partially illegible.

Several issues in using parallel processing for image understanding are addressed. First, efficient schemes for parallel image array access are developed. New class of latin squares called perfect latin squares are defined. Several construction methods are shown and some useful properties of such squares are identified. A generic parallel model of computation employing electro optical devices is developed. Parallel techniques for image computations are developed on this model. Finally, processor time optimal solutions to several low and intermediate level image understanding tasks are designed on orthogonal access parallel architectures.

52567 (AD-A-223578/6/XAB) **Innovative uses of parallel computers. Final report, 1 November 1988-31 October 1989.** Vichniac, G.; Molvig, K. Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. 1 May 1990. 4p. Grant AFOSR-89-0119. Source: NTIS, PC A01/MF A01.

One of the significant discoveries that was made was primarily supported by the ONR and involves the development and extensive simulations of an original model that demonstrates the viability of the lattice-gas approach to hydrodynamics. The model overcomes major difficulties of the previous discrete approaches. These difficulties can be traced to discretization artifacts that introduce a violation of the Galilean invariance and spurious energy terms in the equation of state. (CP)

52568 (AD-A-223754/3/XAB) **Asynchronous design for parallel processing architectures. Semi-annual report, January-June 1990.** Meng, T.H. Stanford Univ., CA (USA). Jun 1990. 3p. Contract N00014-89-J-3036. Source: NTIS, PC A01/MF A01.

The objective of this research is to provide an interconnect design synthesis methodology which facilitates a modular design approach without compromising the global performance. The main tasks of this effort will be the development of the theory for optimal interconnect synthesis from a high-level specification, with emphasis on testability and fault-tolerance asynchronous interface among concurrent computing hardware objects, and the application of this design methodology to physical implementations of parallel processing systems.

52569 (AD-A-223806/1/XAB) **Path planning and obstacle avoidance hybrid system using a connectionist network. (Final report). Master's thesis.** Schuster, C.E. Rice Univ., Houston, TX (USA). Jun 1990. 146p. Source: NTIS, PC A07/MF A01.

Automated path planning and obstacle avoidance has been the subject of intensive research in recent times. Most efforts in the field of semiautonomous mobile-robotic navigation involve using Artificial Intelligence search algorithms on a structured environment to achieve either good or optimal paths. Other approaches, such as incorporating Artificial Neural Networks, have also been explored. By implementing a hybrid system using the parallel-processing features of connectionist networks and simple localized search techniques, good paths can be generated using only low-level environmental sensory data. This system can negotiate structured two- and three-dimensional grid environments, from a start position to a goal, while avoiding all obstacles. Major advantages of this method are that solution paths are good in a global sense and path planning can be accomplished in real time if the system is implemented in customized parallel-processing hardware. This system has been proven effective in solving two- and three-dimensional maze-type environments.

52570 (AD-A-223812/9/XAB) **MUSE - a systolic array for adaptive nulling with 64 degrees of freedom, using Givens transformations and wafer-scale integration. Technical report.** Rader, C.M.; Allen, D.L.; gLASCO , D.B.; Woodward, C.E. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 18 May 1990. 82p. Contract F19628-90-C-0002. (TR-886). Source: NTIS, PC A05/MF A01.

This report describes an architecture for a highly parallel system of computational processors specialized for real-time adaptive antenna nulling computations with many degrees of freedom, which we call MUSE (Matrix Update Systolic Experiment), and a specific realization of MUSE for 64 degrees of freedom. Each processor uses the CORDIC algorithm and has been designed as a single integrated circuit. Ninety-six such processors working together can update the 64-element nulling weights based on 300 new observations in only 6.7 milliseconds. This is equivalent to 2.88 Giga-ops for a conventional processor. The computations are accurate enough to support 50 decibel of signal-to-noise improvement in a sidelobe canceller. The connectivity between processors is quite simple and permits MUSE to be realized on a single large wafer, using restructurable VLSI (Very Large Scale Integration). The complete design of such a wafer is described.

52571 (ANL-87-26-Vol.3, pp. 1-9) **Oscillation of superlinear matrix differential equations.** Ahlbrandt, C.D. (Univ. of Missouri, Columbia (USA)); Ridenhour, J.; Thompson, R.C. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The main theorems extend to matrix differential equations Atkinson's classic theorem giving necessary and sufficient conditions for the oscillation of superlinear second-order scalar differential equations. The theorems improve recent results of Kura and of Butler and Erbe by removing the very restrictive hypothesis that solutions be symmetric. 21 refs.

52572 (ANL-87-26-Vol.3, pp. 11-19) **Spectral analysis of second order boundary problems with indefinite weight functions.** Allegretto, W. (Univ. of Alberta, Edmonton (Canada)). Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The author studies the qualitative behavior of solutions and the spectrum of boundary problems of the form $Au = \lambda Bu$, where A is an ordinary/partial differential operator and B is a multiplication operator by a generally (sign) indefinite weight function. 13 refs.

52573 (ANL-87-26-Vol.3, pp. 21-38) **On the numerical computation of eigenvalues of Sturm-Liouville problems with matrix coefficients.** Atkinson, F.V. (Univ. of Toronto, Ontario (Canada)); Krall, A.M.; Leaf, G.K.; Zettl, A. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The authors describe a method for the numerical computation of the eigenvalues of Sturm-Liouville differential equations with matrix function coefficients. The numerical procedure is based on unitary matrices constructed from the original S-L problem and the monitoring of the eigenvalues of these associated unitary matrices on the unit circle $w_j(x,\lambda)$, $a \le x \le b$. The algorithm uses a search procedure based on tracking these eigenvalues. The search procedure, described below, relies entirely on the behavior of the angles of certain points $w_j(b,\lambda)$ on the unit circle as functions of λ only. As functions of λ these move around the unit circle in a counterclockwise direction as λ increases. These angles are functions of both x and λ. For most problems these points on the unit circle also move counterclockwise as x increases from the left end point a to the right end point b of the basic interval. However, in some problems these points move counterclockwise as x increases through values in a subinterval of [a,b]. It may be these problems that cause the procedure to miss some eigenvalues. In the near future, the authors plan to alter the search algorithm by monitoring the behavior of these certain points on the unit circle in the complex plane as functions of both x and λ. In this way they hope to overcome the above-mentioned problem of missing eigenvalues in certain circumstances. The difficulty encountered can be illustrated in the scalar case. It can occur in situations when the Prufer angle $\Theta(x,\lambda)$, for fixed λ, decreases (rather than increases) as a function of x on part or all of the basic interval [a,b]. A significant feature of the algorithm is the fact that it computes the eigenvalues $\lambda_1 \le \lambda_2 \le \lambda_3 \le \ldots$ in order counting multiplicity. 2 refs., 3 figs., 4 tabs.

52574 (ANL-87-26-Vol.3, pp. 39-48) **Sufficient conditions for weighted sum interpolation inequalities in R^n.** Brown, R.C.

(Univ. of Alabama, Tuscaloosa (USA)); Hinton, D.B. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

Weighted sum inequalities are established for functions defined on a domain in R^n which are contained in an appropriate weighted Sobolev space. The inequalities establish a bound for the integral of the j-th derivative in terms of the integrals of the function of the m-th derivative for $j < m$. The weights in the three integrals are allowed to be different as well as the indices defining the norm. 11 refs.

52575 (ANL–87-26-Vol.3, pp. 49-67) **Asymptotic linearity of solutions of second-order systems of differential equations.** Chen, Shaozhu (Shandong Univ. (China)). Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The author considers the n-dimensional system $U'' + p(t)U = 0$, where p is an $n \times n$ Hermitian matrix-valued function. Necessary and/or sufficient conditions for all solutions to be asymptotic, in varying degrees, to linear matrix functions $tB + A$ are obtained. Systems with linear or nonlinear perturbations are also discussed. 14 refs.

52576 (ANL–87-26-Vol.3, pp. 69-76) **Oscillation theory for systems of second-order differential equations.** Erbe, L.H. (Univ. of Alberta, Edmonton (Canada)); Ganta, L. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The authors obtain some oscillation criteria for the second order differential system $Y'' + Q(t)Y = 0$, where Q,Y are $n \times n$ real matrix-valued functions defined on $[a, +\infty]$ with $Q = Q(t)$ symmetric. 11 refs.

52577 (ANL–87-26-Vol.3, pp. 77-101) **A user's guide to subroutine SPDNSF [Spectral Density Function].** Fulton, C.T. (Florida Institute of Technology, Melbourne (USA)); Pruess, S.A. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

Subroutine SPDNSF (for Spectral Density Function) computes an approximation to the singular spectral function for Sturm-Liouville problems having continuous spectrum over $(0,\infty)$. The approximation is calculated by computing a large number of eigenvalues and norms of eigenfunctions (thousands) over [a,b] for large b and computing the associated step spectral function at a user-selected set of λ-points. The convergence of the step spectral function to the singular spectral function is known to be uniform on compact subsets of the continuous spectrum, a result that is supported by the numerical evidence. The code is restricted to the equation $-u'' + qu = \lambda u$ and written for a type of Sturm-Liouville problem involving liner dependence on λ in the boundary condition at the left endpoint. The code makes use of asymptotic formulas for the large eigenvalues and a shooting algorithm of S. Pruess for the smaller eigenvalues. 6 refs., 3 tabs.

52578 (ANL–87-26-Vol.3, pp. 103-111) **L^2-norm inequalities for the differentiation operator on compact intervals.** Gillman, D.W. (Argonne National Laboratory, IL (USA)); Kaper, H.G.; Kwong, Man Kam. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

In this article the authors establish the best possible value of the constant K in the inequality $\| f' \|^2 \leq K \| f \| \| f'' \|$ for functions f that are defined and twice continuously differentiable on a compact interval $[a,b] \subset R$ and whose first derivative vanishes at some point in [a,b]. 3 refs.

52579 (ANL–87-26-Vol.3, pp. 113-126) **High-order asymptotic approximations to the eigenvalues of Sturm-Liouville problems.** Harris, B.J. (Northern Illinois Univ., DeKalb (USA)). Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The author considers the eigenvalue problem $(py')' + qy = \lambda wy$ $-\infty < a \leq b < \infty$, $y(a) \sin \alpha - p(a)y'(a) \cos \alpha = 0$, $y(b) \cos \beta + p(b)y'(b) \sin \beta = 0$ for $\alpha, \beta \in [0,\pi]$. He drives estimates of the eigenvalues, λ_n, of the form $\lambda_n = \phi(n) + 0(n^{-k})$, where the constant k increases with the smoothness of p,q and w. 9 refs.

52580 (ANL–87-26-Vol.3, pp. 127-134) **Landau's inequality for the difference operator.** Kwong, Man Kam (Argonne National Laboratory, IL (USA)); Zettl, A. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

The best constants for Landau's inequality with the classical p-norms are known explicitly only when $p = 1$, 2, and ∞. This is true for both the discrete and the continuous versions of the inequality and for both the whole line and half line cases. In each of the six known cases the best constant for the discrete version is the same as the best constant for the continuous version. Here the authors show that for many other values of p the discrete constants are strictly greater than the corresponding continuous ones. In addition, they show that the three norm version of the inequality, established by Nirenberg and Gabushin in the continuous case, is also valid in the discrete case. 8 refs.

52581 (ANL–87-26-Vol.3, pp. 135-145) **Remarks on the first eigenspace for polyharmonic operators.** Pucci, P. (Universita degli Studi di Modena (Italy)); Serrin, J. Argonne National Lab., IL (USA). Apr 1989. In *Proceedings of the focused research program on spectral theory and boundary value problems: Volume 3, Linear differential equations and systems.* 153p. Order Number DE89011499. Source: NTIS, PC A08/MF A01 - OSTI.

This paper considers several questions concerning the first eigenvalue and eigenspace of the polyharmonic operator with Dirichlet boundary conditions. 4 refs.

52582 (CBPF-MO–001/89, pp. 107-131) **Project for the development of a calculation system based on PC-compatible ordenators to be used on teaching and research on theoretical chemistry.** Carbo, R. (Girona Col.legi Univ. (Spain). Unitat de Quimica); Calabuig, B. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1988. (In Spanish). (CONF-8809499–: 6. Latin American School on Theoretical Chemistry, Rio de Janeiro (Brazil), 11-17 Sep 1988). In *6. Latin American School on Theoretical Chemistry. v. 1.* 301p. Source: Available from the Library of the Comissao Nacional de Energia Nuclear, RJ, Brazil.

The basis for the construction of an IBM-PC compatible calculation system, is exposed, as well as, the necessary elements for its construction. (A.C.A.S.).

52583 (DOE/ER/25084–T1) **The modeling of complex continua: Fundamental obstacles and grand challenges: Progress report.** State Univ. of New York, Stony Brook, NY (USA). Research Foundation. [1990]. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-90ER25084. Order Number DE91000829. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses: discontinuities and adaptive computation; chaotic flows; oil reservoir simulation; and parallel computation.

52584 (JAERI-M–90-100) **Visualization of computed results.** Tsuruoka, Takuya (Nuclear Energy Data Center, Tokai, Ibaraki (Japan)); Ishiguro, Misako. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1990. 53p. (In Japanese). Order Number DE91713043. Source: NTIS (US Sales Only), PC A04/MF A01.

Visualization of computed results has become an indispensable means to get better understanding of physical phenomena. In this circumstances, a trial of visualization has started at JAERI in 1989.

The examples, tried so far, are animations of three kinds of physical phenomena: heat flow behavior in a curved pipe, transient behavior of molten metals heated by electron beam in laser isotope separation process, and Xenon-induced oscillation behavior in the core of the high temperature gas-cooled test reactor. Each animated graph is recorded on a video tape of several minutes. Three-dimensional color graphics software FACOM CGMS, which runs on FACOM VP or M-780 systems, has been used for this purpose. This report describes the visualization methods used for these graphic applications. (author).

52585 (JAERI-M–90-108) **Vectorization of DOT3.5 code: DOT3.5 NEA version, DOT3.5 FNS version, DOT3.5 FER version, RADHEAT-V4, DOT-DD.** Nonomiya, Iwao (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Ishiguro, Misako; Tsutsui, Tsuneo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1990. 85p. (In Japanese). Order Number DE91713056. Source: NTIS (US Sales Only), PC A05/MF A01.

In this report, we describe the vectorization of two-dimensional Sn-method radiation transport code DOT3.5. Vectorized codes are not only the NEA original version developed at ORNL but also the versions improved by JAERI: DOT3.5 FNS version for fusion neutronics analyses, DOT3.5 FER version for fusion reactor design, and ESPRIT module of RADHEAT-V4 code system for radiation shielding and radiation transport analyses. In DOT3.5, input/output processing time amounts to a great part of the elapsed time when a large number of energy groups and/or a large number of spatial mesh points are used in the calculated problem. Therefore, an improvement has been made for the speedup of input/output processing in the DOT3.5 FNS version, and DOT-DD (Double Differential cross section) code. The total speedup ratio of vectorized version to the original scalar one is 1.7≈1.9 for DOT3.5 NEA version, 2.2≈2.3 fro DOT3.5 FNS version, 1.7 for DOT3.5 FER version, and 3.1≈4.4 for RADHEAT-V4, respectively. The elapsed times for improved DOT3.5 FNS version and DOT-DD are reduced to 50≈65% that of the original version by the input/output speedup. In this report, we describe summary of codes, the techniques used for the vectorization and input/output speedup, verification of computed results, and speedup effect. (author).

52586 (JAERI-M–90-114) **Quality control of the software in the JT-60 computer control system.** Isaji, Nobuaki (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kurihara, Kenichi; Kimura, Toyoaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1990. 32p. (In Japanese). Order Number DE91713057. Source: NTIS (US Sales Only), PC A03/MF A01.

The JT-60 Control System should be improved corresponding to the experimental requirements. In order to keep the integrity of the system even in the modification the concept of quality control (QC) was introduced in the software development. What we have done for QC activity are (1) to establish standard procedures of the software development, (2) to develop support tools for grasping the present status of the program structure, and (3) to develop a document system, and a source program management system. This paper reports these QC activities and their problems for the JT-60 control system. (author).

52587 (LA-UR–90-3145) **Managing computer security: How can research help?.** Bailey, D.J. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9010195–1: ESORICS '90, Toulouse (France), 24-26 Oct 1990). Order Number DE91000230. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper points out significant problems in managing the security of large systems. Addressed to the research community, it suggests research questions whose solution would benefit the people charged with protecting actual systems, and, hence, would create real improvements in system security. The problems of managing connection-rich distributed systems are discussed, and a research direction leading to a solution for the problems of distributed systems is suggested.

52588 (LBL–26455, pp. 76) **Exact solution of a periodic-cluster Hubbard model with an electron-lattice interaction.** Proetto, C.R.; Falicov, L.M. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

An exact solution of a modified Hubbard model for a tetrahedral cluster with periodic boundary conditions is presented. It includes a static electron-lattice interaction in which the intersite bond-hopping parameter is a function of the bond electron occupation. It is found that the intrasite Coulomb repulsion and the effective attractive electron-lattice interaction have, generally speaking, opposite (although not identical) effects. They cancel each other exactly along a line of singularities in parameter space. The state vectors are easily obtained analytically. A study is made of magnetic and super-conducting static correlation functions as functions of the parameters. Various forms of anisotropic superconducting fluctuations are favored in the various regimes. There is an indication of possible states with coexisting nonuniform, nonisotropic superconductivity and antiferromagnetism caused by a compromise between the competing forces.

52589 (LBL–26455, pp. 77) **Heavy-fermion system: Superconducting and magnetic fluctuations within a periodic-Cluster Hubbard model.** Reich, A.; Falicov, L.M. Lawrence Berkeley Lab., CA (USA). Jul 1989. In *Materials and Chemical Sciences Division annual report, 1988.* 236p. Order Number DE90003301. Source: NTIS, PC A11/MF A01.

An exact solution of an eight-site crystal model with periodic boundary conditions, a small face-centered-cubic crystal, is presented for the case of a heavy-fermion system. The model consists of (a) a single, fully symmetric orbital per site, with nearest-neighbor and second-nearest-neighbor hopping; (b) an infinite Coulomb repulsion between electrons on the same site; (c) antiferromagnetic superexchange interactions; and (d) band fillings near half filling (six, seven, and eight electrons per cluster). The superconducting and the antiferromagnetic correlations are studied and compared with the predictions of the noninteracting limit. The suitability of Bardeen-Cooper-Schrieffer and Gutzwiller approximate ground-state wave functions are quantitatively estimated.

52590 (LBL–29301) **The practical computer in design.** Schuman, J.; Ward, G. Lawrence Berkeley Lab., CA (USA). Jul 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9008156–1: 5. ICSRIC-90: international conference on systems research, informatics and cybernetics, Baden-Baden (German Democratic Republic), 6-12 Aug 1990). Order Number DE91000353. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Electronic information processing is becoming a necessity in today's complex design environment, but what is an appropriate role for the computer in the design process? Computation should be applied throughout all design phases, but practicing designers today rarely use computers beyond simple word processing and drafting tasks. While many design tasks are poorly matched to the computer, other pragmatic and productive avenues remain unexploited. We discuss the need to recognize which elements of the design process are most suited to computer assistance. The authors define a role for the computer as an objective assistant to the designer, and discuss practical approaches in two application areas for computers in design: design simulation and resource information management.

52591 (LUSG-WP–528) **Software for energy modelling: a theoretical basis for improvements in the user interface.** Siu, Y.L. Leeds Univ. (UK). School of Geography. Sep 1989. 44p. Source: Available from School of Geography, University of Leeds, Leeds LS2 9JT.

A philosophical critique of the relationships between theory, knowledge and practice for a range of existing energy modelling styles is presented. In particular, Habermas's ideas are invoked regarding the three spheres of cognitive interest (i.e. technical, practical and emancipatory) and three levels of understanding of knowledge, the construction of an 'ideal speech situation', and the theory of communicative competence and action. These are adopted as a basis for revealing shortcomings of a representative selection of existing computer-based energy modelling styles, and

as a springboard for constructing a new theoretical approach. (author).

52592 (ORAU–89/C-140, pp. 21-35) **Man-machine communication for symbiotic control.** Sheridan, T.B. (Massachusetts Institute of Technology, Cambridge (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

As telerobotic and other systems are asked to do more sophisticated tasks, the communication between man and machine becomes more critical. This paper specifies communication functions and forms both of human and computer, discusses telerobotic control activities about which communication is essential in relation to the human's metal model and the computer's internal model, gives examples of critical research areas in man-machine communication, and suggests appropriate performance measures. 15 refs., 5 figs., 2 tabs.

52593 (ORAU–89/C-140, pp. 99-127) **Human-machine system architecture: The design of cooperative teams of human and computer decision makers.** Mitchell, C.M. (Georgia Institute of Technology, Atlanta (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

As computer technology becomes both more sophisticated and more affordable, design issues become more challenging. In complex, dynamic systems, computers can be used to replace human decision makers, to enhance decision making via decision aiding, or to amplify human potential by providing the human operator an associate or assistant in the decision making process. In complex systems, uncertainty associated with system dynamics and the costs and risks associated with system malfunction make the first option, replacement of the human decision maker with a computer decision maker, an unrealistic alternative. Recent research has shown that display enhancement is a design alternative that has proved successful in reducing operator workload and increasing operator effectiveness. This paper describes research that examines the feasibility and effectiveness of the third alternative-design teams of decision makers that include both humans and computers. This design strategy is sometimes called an operator's associate. The function of an associate is to provide intelligent assistance for the human operator of a complex dynamic system. The basis for intelligent, context-sensitive advice and reminders is the ability of the associate to infer likely operator intentions in real time. Such human-computer architectures draw heavily on artificial intelligence models. This paper discusses the general requirements for an operator's associate and presents an overview of three components of an on-going research project: (OFMspert Operator Function Model expert system), a particular architecture of an intelligent operator's associate; ACTIN, OFMspert's intent-inferencing mechanism; and Ally, an implementation of OFMspert with system control functions. 23 refs., 11 figs., 2 tabs.

52594 (ORAU–89/C-140, pp. 145-147) **Breakout session: Human-machine communication.** Beckerman, M. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

The participants' interests in human-machine symbiotic systems were varied, ranging from the design of systems for handicapped individuals such as quadriplegics to the building of near-earth satellite operator's associates for NASA to robotics for handling nuclear power plant accidents. At the conclusion of the session, the group on Human-Machine Communication observed that there are two immediate, promising areas of research into communications in human-machine symbiotic systems. These high priority areas are: (1) The simultaneous (concurrent) and integrated use of multiple modalities, or sensor channels, for communication between man and machine and (2) the development of models of the human operator within intelligent computer systems, with emphasis on characteristics present during periods of both nominal and unusual arousal and stress. 1 fig.

52595 (ORAU–89/C-140, pp. 129-141) **Toward a learning robot.** Mitchell, T.M. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)); Mason, M.T.; Christiansen, A.D. Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

The problem of robot manipulation-of planning how to successfully grasp, push, and pull arbitrary objects to reconfigure them as desired-is an unsolved problem in robotics. A hand-eye system is presently being developed which is intended to begin with simple knowledge about how to manipulate its world, and to itself acquire increasingly refined knowledge about manipulation in specialized contexts. For example, the robot may begin with knowledge such as to move an object somewhere to the right, push from some point on the left, and may refine the knowledge through experience into more specific, more precise assertions such as to move object which is in contact with a wall to the right in a straight line, push from a point on the left which is 2/3 of the distance from the wall. The learning method is a type of explanation-based generalization driven by an incomplete theory of the domain-in particular by a theory for qualitative differential analysis. This paper presents an approach to constructing a planning/learning system of this kind, and is primarily organized around a hand-generated example of the type of behavior our system is intended to exhibit. 10 refs., 5 figs.

52596 (ORAU–89/C-140, pp. 149-151) **Breakout session: Autonomous task planning and execution monitoring.** Mann, R.C. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

The discussion in this session focused on mainly two areas: (1) interpretations of the scope of and rationale for human-machine symbiosis and (2) issues involved in autonomous task planning. Symbiosis can be viewed as an approach to bridge the gap between the majority of robotic systems today that are capable of performing complex tasks under full teleoperation or after being preprogrammed and those few prototype systems capable of autonomous behavior for simple assignments. The issue in symbiosis is not autonomy versus teleoperation but a dynamic mixture of both modes of robot operation. It was pointed out that the concepts considered in symbiosis do not apply only to human-robot systems. An example presented was the interaction between a human and an intelligent data base system through a computer work station. In any event, autonomy is a prerequisite for symbiosis. Furthermore, the group maintained that autonomy is not synonymous to intelligence. Task planning refers to the decomposition of a symbolic goal description into a sequence of tasks with associated numeric descriptions that can be executed by the different agents in the symbiotic system. Prerequisites for task planning include an appropriate goal description; models for the current environment and agents and other resources available to the system, as well as adequate definitions of possible constraints under which the goal must be achieved, e.g., limited. time. 2 figs.

52597 (ORAU–89/C-140, pp. 153-156) **Breakout session: Dynamic task allocation.** Manges, W. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

The group began by developing a list of the attributes of the best approaches to dynamic task allocation. The resulting list included such factors as timeliness, coherence, load balance, and risk. Subsequent discussion detailed the importance of various architectural, human interface, and measurement issues in designing a human-machine symbiotic system that optimizes the allocation attributes for the current application. The group concluded by emphasizing the importance of on-line observers and other intelligent mechanisms to dynamically assess the progress and directedness of the agents of the dynamic task allocation implementation in achieving the defined tasks. Topics recommended for further research included improved measurements, architectures, relative human-machine roles, and task granularity.

52598 (ORAU–89/C-140, pp. 157-161) **Breakout session: Human-machine system architecture.** DePiero, F.W. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

This session of the workshop focused on the subject of human-machine symbiotic (H-MS) system architecture. The session began with an agreement on the definition of an architecture. Two examples were discussed, and then, to focus the discussion, the following question was considered; Is there a canonical human-machine symbiotic system architecture, or are there only good design rules? This question provoked many suggestions of what a good architecture might be. It became clear that a set of criteria was needed to evaluate the merits of an architecture. Throughout the session many areas of potential research were also identified. 2 figs.

52599 (ORAU–89/C-140, pp. 163-170) **Breakout session: Machine learning via experience and human observation.** Spelt, P.K. (Oak Ridge National Laboratory, TN (USA)). Oak Ridge National Lab., TN (USA); Oak Ridge Associated Universities, Inc., TN (USA). 1989. (CESAR–89/19;CONF-881281–: Workshop on human-machine symbiotic systems, Oak Ridge, TN (USA), 5-6 Dec 1988). In *1988 workshop on human-machine symbiotic systems proceedings.* 196p. Order Number DE89013888. Source: NTIS, PC A09/MF A01.

Considerable time and effort were spent to define the terms Learning and Symbiosis in the Human-Machine Symbiosis context. While the original question for the group was not directly answered, the issues railed by the 5 questions presented below should serve as areas of focus for research on human-machine symbiosis in the next few years. The utility of both inductive, data-driven learning systems and deductive, knowledge-driven systems was highlighted, and there was some suggestion that a blending of the two approaches would be good. The 5 questions are: 1. What role should learning play in a Machine and Human symbiotic relationship? 2. Can learning improve system performance as opposed to improved machine performance with overall lowered system performance? 3. What is learnable? What kinds of subtasks could the machine learn, and what must (should) remain with the human? 4. Should the Human always be in control, or are there times when it is permissible for the machine to be in control? 5. When is Machine Leaning useful? 1 fig.

52600 (ORNL/TM–11661) **Adapting sensory data for multiple robots performing spill cleanup.** Storjohann, K.; Saltzen, E. Oak Ridge National Lab., TN (USA). Sep 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE91000689. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a possible method of converting a single performing robot algorithm into a multiple performing robot algorithm without the need to modify previously written codes. The algorithm to be converted involves spill detection and clean up by the HERMIES-III mobile robot. In order to achieve the goal of multiple performing robots with this algorithm, two steps are taken. First, the task is formally divided into two sub-tasks, spill detection and spill clean-up, the former of which is allocated to the added performing robot, HERMIES-IIB. Second, a inverse perspective mapping, is applied to the data acquired by the new performing robot (HERMIES-IIB), allowing the data to be processed by the previously written algorithm without re-writing the code. 6 refs., 4 figs.

52601 (PB–90-254012/XAB) **Annotated bibliography on parallel parsing.** op den Akker, R.; Alblas, H.; Nijholt, A.; Luttighuis, P.O. Technische Univ. Twente, Enschede (Netherlands). Dept. of Computer Science. Dec 1989. 39p. (MEMO-INF–89-67). Source: NTIS, PC A03/MF A01.

The annotated bibliography on parallel parsing and recognition of context-free languages covers most of the important publications in this fast growing area of computer science and natural language processing. The list of publications is preluded by an introduction which presents an overview of the field.

52602 (PB–90-237387/XAB) **Supercomputer simulation of ITO stochastic differential equations. Phase 1.** Petersen, W.P. Principia Supervectus, Inc., Seattle, WA (USA). 16 Sep 1987. 69p. Grant NSF-ISI8660377. Source: NTIS, PC A04/MF A01.

It was the intent of the project to improve the methods for simulating stochastic differential equations, both in terms of optimizing computer codes for execution time and improving the accuracy of determining functionals of the simulated process. By appropriate modifications of the existing theory about stability in numerical methods for ordinary differential equations, researchers found encouraging results for stochastic differential equations. They concluded that sample sizes and stability are far more important than the step size for obtaining satisfactory results. The methods are well adapted for vector or parallel computers. Examining vector/parallel computing methods for such processes inspires new methods for generating uniform and gaussian random numbers and produces a new and welcome attitude change about such simulations.

52603 (PNL-SA–17937) **Efficient iteration in data-parallel programs with irregular and dynamically distributed data structures.** Littlefield, R.J. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Grant CCR-8619663;Grant CCR-9807666. (CONF-900874–4: 1990 international conference on parallel processing, St. Charles, IL (USA), 13-17 Aug 1990). Order Number DE91000417. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To implement an efficient data-parallel program on a non-shared memory MIMD multicomputer, data and computations must be properly partitioned to achieve good load balance and locality of reference. Programs with irregular data reference patterns often require irregular partitions. Although good partitions may be easy to determine, they can be difficult or impossible to implement in programming languages that provide only regular data distributions, such as blocked or cyclic arrays. We are developing Onyx, a programming system that provides a shared memory model of distributed data structures and extends the concept of data distribution to include irregular and dynamic distributions. This provides a powerful means to specify irregular partitions. Perhaps surprisingly, programs using it can also execute efficiently. In this paper, we describe and evaluate the Onyx implementation of a model problem that repeatedly executes an irregular but fixed data reference pattern. On an NCUBE hypercube, the speed of the Onyx implementation is comparable to that of carefully handwritten message-passing code.

52604 (PNL-SA–18372) **Proceedings of the CEC/USDOE workshop on uncertainty analysis.** Elderkin, C.E. (Pacific Northwest Lab., Richland, WA (USA)); Kelly, G.N. (eds.). Pacific Northwest Lab., Richland, WA (USA). Sep 1990. 78p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (EUR–13044-EN;CONF-8911195–: CEC/USDOE workshop on uncertainty analysis, Santa Fe, NM (USA), 13-16 Nov 1989). Order Number DE91000454. Source: NTIS, PC A05/MF A01 - OSTI; GPO Dep.

In recent years it has become increasingly important to specify the uncertainty inherent in consequence assessments and in the models that trace radionuclides from their source, through the environment, to their impacts on human health. European and US scientists have, been independently developing and applying methods for analyzing uncertainty. It recently became apparent that a

scientific exchange on this subject would be beneficial as improvements are sought and as uncertainty methods find broader application. The Commission of the European Communities (CEC) and the Office of Health and Environmental Research of the US Department of Energy (OHER/DOE), through their continuing agreement for cooperation, decided to co-sponsor the CEC/USDOE Workshop on Uncertainty Analysis. CEC's Radiation Protection Research Programme and OHER's Atmospheric Studies in Complex Terrain Program collaborated in planning and organizing the workshop, which was held in Santa Fe, New Mexico, on November 13 through 16, 1989. As the workshop progressed, the perspectives of individual participants, each with their particular background and interests in some segment of consequence assessment and its uncertainties, contributed to a broader view of how uncertainties are introduced and handled. This proceedings contains, first, the editors' introduction to the problem of uncertainty analysis and their general summary and conclusions. These are then followed by the results of the working groups, and the abstracts of individual presentations.

52605 (SAND–90-0416) **Finite element error estimation and adaptivity based on projected stresses.** Jung, J. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 73p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000483. Source: NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report investigates the behavior of a family of finite element error estimators based on projected stresses, i.e., continuous stresses that are a least squared error fit to the conventional Gauss point stresses. An error estimate based on element force equilibrium appears to be quite effective. Examples of adaptive mesh refinement for a one-dimensional problem are presented. Plans for two-dimensional adaptivity are discussed. 12 refs., 82 figs.

52606 (SAND–90-1813C) **Living with Omniback and the 8mm drive.** Jones, M.C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9009259–1: Apollo domain users' society workstation conference, San Diego, CA (USA), 30 Sep - 4 oct 1990). Order Number DE91000022. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Apollo's OmniBack backup system provides a convenient and effective way of storing network backup information on 8mm tape. In addition it has a journaling facility to write extensive log files, recording the backup process in almost any degree of detail desired. The directory structure and file names used are logical and well-defined. Summary files announce the degree of success of the backup as specified in the work file. The system will run unattended under the UNIX cron command, allowing the backup to be performed during the night when user demands on the network are small and most user files are free.

52607 (UCID–21566) **INGRID by example: A pictorial tutorial.** Rainsberger, R. Lawrence Livermore National Lab., CA (USA). Nov 1988. 117p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE91000481. Source: NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The following examples of INGRID input files and results are from various sources including Doug Stillman. In many cases, they are the same as in the examples section of the INGRID manual by Doug Stillman. I have made some modest improvements so that they are all complete input files to be run with the latest version of INGRID. These files have been attached to the front end of the INGRID source as comments. I wish to invite all INGRID user's to submit any favorite input files to be included in this tutorial. Such an input file should not be too large, and the object being generated should have a natural appeal to INGRID users. Feel free to make suggestions. This tutorial will soon replace the examples section of the manual. The entire manual will be replaced a section at a time. I chose to do this section first, since it could give the most benefit in the shortest amount of time. As soon as I make INGRID interactive, I will then rewrite the section on standard parts.

52608 (USGS-OFR–89-139) **FREQFIT: Computer program which performs numerical regression and statistical chi-squared goodness of fit analysis.** Hofland, G.S.; Barton, C.C. Geological Survey, Denver, CO (USA). 1990. 62p. Sponsored by U.S. DOE Radioactive Waste Management; U.S. Geological Survey. DOE Contract AI08-78ET44802. Order Number DE91000133. Source: NTIS, PC A04/MF A01; OSTI; INIS; US Geological Survey, Books and Open-File Reports Section, Box 25425 Federal Center, Denver CO 80225; GPO Dep.

The computer program FREQFIT is designed to perform regression and statistical chi-squared goodness of fit analysis on one-dimensional or two-dimensional data. The program features an interactive user dialogue, numerous help messages, an option for screen or line printer output, and the flexibility to use practically any commercially available graphics package to create plots of the program's results. FREQFIT is written in Microsoft QuickBASIC, for IBM-PC compatible computers. A listing of the QuickBASIC source code for the FREQFIT program, a user manual, and sample input data, output, and plots are included. 6 refs., 1 fig.

52609 **Efficient bit-level, word-level, and block-level systolic arrays for matrix-matrix multiplication.** DeGroot, A.J. (Lawrence Livermore National Lab., Livermore, CA (US)); Parker, S.R.; Johansson, E.M. pp. 107-115 of High speed computing: Volume 880. Casasent, D.P. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). pp. 224 (CONF-8801146–: High speed computing meeting, Los Angeles, CA (USA), 11-12 Jan 1988).

This paper investigates the mapping of matrix-matrix multiplication onto bit level, word level and block level systolic arrays. Highly efficient and regular bit level, word level and block level systolic arrays are described. Efficiencies of many block level and word level systolic arrays reported in this paper approach 100%, three times the efficiencies of systolic arrays reported previously. Bit level systolic arrays reported in this paper require less computation time than do bit level systolic arrays reported previously and, for special matrices, require less cells. Execution times of block level systolic algorithms on a sixty-four-element multiprocessor agree with theory.

9903 Information Handling

Refer also to citation(s) 50884, 51544, 51628, 51777, 52351, 52569, 52601

52610 (DOE/EIA–0204(90/04)) **Energy Information Administration New Releases, July–August 1990.** Jacobus, P. (ed.); Springer, I. USDOE Energy Information Administration, Washington, DC (USA). Sep 1990. 16p. Sponsored by U.S. DOE Office of Administration and Human Resource Management. Order Number DE91000674. Source: NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.

"New Releases" is Energy Information Administration's news letter, which reports its activities, publications, and machine-readable data files and modeling programs. For each publication or report, an abstract, subscription price, availability, and other bibliographical information are included. It covers crude oil, natural gas, and natural gas liquids reserves, coal, electricity, nuclear fuel, renewable energy and conservation, and petroleum. Order forms are also provided.

52611 (DOE/ER/75527–2) **Design, develop, test, and implement an on-line research and education information service: Technical status report, September 30, 1989–September 30, 1990.** Federal Information Exchange, Inc., Germantown, MD (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER75527. Order Number DE90017654. Source: NTIS, PC A02/MF A01 - OSTI; GPO Dep.

On September 30, 1989, Federal Information Exchange, Inc. received a grant from the Department of Energy (DOE) to operate the DOEINFO system, convert it to the FEDIX system, enlarge its scope to include programs at Argonne, Brookhaven, Lawrence Berkeley, Oak Ridge and Pacific Northwest Laboratories and add the National Aeronautics and Space Administration (NASA) and the Office of Naval Research (ONR) to the system. FEDIX has been developed to give DOE, ONR, and NASA maximum editorial control over the content of the information provided on-line. Procedures have been developed to ensure maximum consultation

between Agency staff and Federal Information Exchange, Inc. The key features that have made FEDIX attractive to the user community include: ease of use, no service charge, quality information, search by keywords, download capacity comprehensive information, and participation of several agencies. The objective and milestones outlined in the FEDIX proposal are on schedule and work requirements have been met. During the next six months all proposed work will be accomplished.

52612 (LBL-PUB–3081) **TOOLKIT, Version 2.0.** Schroeder, E.; Bagot, B.; McNeill, R.L. Lawrence Berkeley Lab., CA (USA). 9 May 1990. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE91000378. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this User's Guide is to show by example many of the features of Toolkit II. Some examples will be copies of screens as they appear while running the Toolkit. Other examples will show what the user should enter in various situations; in these instances, what the computer asserts will be in boldface and what the user responds will be in regular type. The User's Guide is divided into four sections. The first section, "FOCUS Databases", will give a broad overview of the Focus administrative databases that are available on the VAX; easy-to-use reports are available for most of them in the Toolkit. The second section, "Getting Started", will cover the steps necessary to log onto the Computer Center VAX cluster and how to start Focus and the Toolkit. The third section, "Using the Toolkit", will discuss some of the features in the Toolkit – the available reports and how to access them, as well as some utilities. The fourth section, "Helpful Hints", will cover some useful facts about the VAX and Focus as well as some of the more common problems that can occur. The Toolkit is not set in concrete but is continually being revised and improved. If you have any opinions as to changes that you would like to see made to the Toolkit or new features that you would like included, please let us know. Since we do try to respond to the needs of the user and make periodic improvement to the Toolkit, this User's Guide may not correspond exactly to what is available in the computer. In general, changes are made to provide new options or features; rarely is an existing feature deleted.

52613 (ORNL/TM–11627) **A conceptual design for a graphics output interface for the Worldwide Household Goods Information System for Transportation Modernization (WHIST-MOD).** Loftis, J. (Oak Ridge National Lab., TN (USA)); James, T. Oak Ridge National Lab., TN (USA). Aug 1990. 23p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90018036. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Directorate of Personal Property of the Military Traffic Management Command (MTMC) requested that Oak Ridge National Laboratory (ORNL) design and prototype a decision support system, the Worldwide Household Goods Information System for Transportation Modernization (WHIST-MOD). This decision support system will automate current tasks and provide analysis tools for evaluating the Personal Property Program, predicting impacts to the program, and planning modifications to the program to meet the evolving needs of military service members and the transportation industry. The system designed by ORNL consists of three application modules: system dictionary applications, data acquisition and administration applications, and user applications. The development of the user applications module is divided into two phases. Round 1 is the data selection front-end interface, and Round 2 is the output or back-end interface. This report describes the conceptual design for the back-end output interface of the user applications module, which will be prototyped using SAS, a data management and statistical analysis toolset. This report discusses our goals for the back-end interface and describes how we plan to meet these goals. Our design fulfills the users' needs for a flexible interface that can be used to produce a variety of tabular and graphical output. 4 figs.

52614 (SAND–89-0738) **WhiteStar user's guide.** Ezell, T.F. Sandia National Labs., Albuquerque, NM (USA). Aug 1990. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE91000094. Source: NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The WhiteStar project provides design engineers with needed part design data. WhiteStar encourages the use of preferred parts by providing a user-convenient parts database. This report shows selections the user makes in order to obtain information on a particular part. 15 figs.

Corporate Author Index

This index lists the corporate authors responsible for issuing the documents in this publication which are identified primarily by report number. The corporate names are entered in standardized forms as defined in *DOE Energy Data Base: Corporate Author Entries* (DOE/TIC-4585). Each entry under a corporate name includes the document title and citation number. Three items of information may appear in parentheses: (1) an abbreviation to identify the document type, such as a report; (2) the country of publication, also abbreviated; and (3) the language of the document if non-English (R;US;In French). Author affiliations are not listed in this index.

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AI79-87BP37474	Nez Perce Tribe Dept. of Fisheries Management (USA)	
	15:50699	DOE/BP/37474–2
AI79-89BP98379	National Marine Fisheries Service, Portland, OR (USA)	
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	15:50702	DOE/BP/98379–2
	15:50703	DOE/BP/98379–3
	15:50704	DOE/BP/98379–4
	15:50705	DOE/BP/98379–5
AS04-81EV10596	New Mexico Univ., Albuquerque, NM (USA). School of Medicine	
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	15:51368	DOE/EV/10596–T4
	15:51369	DOE/EV/10596–T5
	New Mexico Univ., Albuquerque, NM (USA). Dept. of Radiology	
	15:51366	DOE/EV/10596–T2
	15:51370	DOE/EV/10596–T6
AS05-80ER10713	Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA)	
	15:52014	DOE/ER/10713–10
BI79-84BP13381	Idaho Dept. of Fish and Game, Boise, ID (USA)	
	15:50694	DOE/BP/13381–5
BI79-84BP18965	Montana Dept. of Fish, Wildlife and Parks, Libby, MT (USA)	
	15:50698	DOE/BP/36136–1
BI79-87BP35165	Nez Perce Dept. of Fisheries Resource Management, Orofino, ID (USA). Orofino Project Office	
	15:50696	DOE/BP/35165–3
BI79-87BP36136	Montana Dept. of Fish, Wildlife and Parks, Libby, MT (USA)	
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BI79-88BP38372	Oregon Dept. of Fish and Wildlife, Portland, OR (USA)	
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FC03-87ER60615		
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FC03-89SF17960	Oregon Univ., Eugene, OR (USA). Center for Housing Innovation	
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FC05-85ER25000	Argonne National Lab., IL (USA)	
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FC07-85ID12613	Geothermal Resources International, Inc., San Mateo, CA (USA)	
	15:50748	DOE/ID/12613–1
FC07-85NV10425	Louisiana State Univ., Baton Rouge, LA (USA). School of Geoscience	
	15:50749	DOE/NV/10425–T2
FC21-86MC11076	Western Research Inst., Laramie, WY (USA)	
	15:50333	DOE/MC/11076–2862
	15:50534	DOE/MC/11076–2835
	15:50538	DOE/MC/11076–2832
FC21-87MC24207	West Virginia Univ., Morgantown, WV (USA). Dept. of Civil Engineering	
	15:50363	DOE/MC/24207–2852
	West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering	
	15:50362	DOE/MC/24207–2849
FC22-83FE60149	National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)	
	15:50499	NIPER–501
FC22-90PC89659	Environmental Resources Management, Inc., West Chester, PA (USA)	
	15:50274	DOE/PC/89659–T1
FG01-82NE34082	Belgonucleaire S.A., Brussels (Belgium)	
	15:50783	DOE/NE/34082–1
FG01-86CE15270	Missouri Univ., Columbia, MO (USA)	
	15:51839	DOE/CE/15270–T15
FG01-87CE15345	Tubesonics International, Inc., Norman, OK (USA)	
	15:50449	DOE/CE/15345–T4
FG01-89CE15453	Humbug Mountain Research Labs., Duarte, CA (USA)	
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FG01-89CE34025	Midwest Research Inst., Kansas City, MO (USA)	
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FG02-84ER13242	Massachusetts Univ., Boston, MA (USA)	
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FG02-84ER13243		
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FG02-84ER13276		
	15:50298	Published article
FG02-84ER45131	Pittsburgh Univ., PA (USA)	
	15:52273	DOE/ER/45131–8
FG02-84ER45170	Missouri Univ., Kansas City, MO (USA)	
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FG02-84ER53175	Missouri Univ., Rolla, MO (USA). Dept. of Physics	
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FG02-84ER53179		
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FG02-84ER53187		
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FG02-84ER53188	Missouri Univ., Rolla, MO (USA)	
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FG02-84ER60241	Marine Biological Lab., Woods Hole, MA (USA). Ecosystems Center	
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FG02-85ER13331	Argonne National Lab., IL (USA)	
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FG02-85ER40209	Wayne State Univ., Detroit, MI (USA). Dept. of Physics and Astronomy	
	15:52085	DOE/ER/40209–11
FG02-85ER40213	Arizona Univ., Tucson, AZ (USA). Dept. of Physics	
	15:52053	DOE/ER/40213–7
FG02-85ER45219	Missouri Univ., Rolla, MO (USA)	
	15:51183	DOE/ER/45219–4
FG02-86ER13484	Argonne National Lab., IL (USA)	
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FG02-86ER13504		
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FG02-86ER13522		
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FG02-86ER13566	Argonne National Lab., IL (USA)	
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FG02-86ER45239	State Univ. of New York, Stony Brook, NY (USA). Research Foundation	
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FG02-86ER45281	Miami Univ., FL (USA)	
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FG02-86ER53218		
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FG02-86ER53223		
	15:52467	CONF-8905120–
FG02-87ER13695		
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FG02-87ER13720	Colorado Univ., Boulder, CO (USA)	
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FG02-87ER13800	Minnesota Univ., Minneapolis, MN (USA). Dept. of Mechanical Engineering	
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FG02-87ER40333	Wyoming Univ., Laramie, WY (USA)	
	15:51954	DOE/ER/40333–T3
FG02-87ER40334	Brown Univ., Providence, RI (USA). Dept. of Physics	
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FG02-87ER45333		
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FG02-87ER60547	New York Univ., NY (USA). Dept. of Environmental Medicine	
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FG02-88ER13913	Argonne National Lab., IL (USA)	
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FG02-88ER13927	Argonne National Lab., IL (USA)	
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FG02-88ER13929	Argonne National Lab., IL (USA)	
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FG02-88ER13937		
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FG02-88ER13964	Argonne National Lab., IL (USA)	
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FG02-88ER40388		
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FG02-88ER45376	Rochester Univ., NY (USA). Lab. for Laser Energetics	
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FG02-88ER53264		
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FG02-88ER60636	Johns Hopkins Univ., Baltimore, MD (USA)	
	15:51786	DOE/ER/60636–3
FG02-88ER60648		
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FG02-89ER14019	Argonne National Lab., IL (USA)	
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FG02-89ER14039		
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FG02-89ER14043	Argonne National Lab., IL (USA)	
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FG02-89ER14045	Argonne National Lab., IL (USA)	
	15:51406	CONF-9005183–
FG02-89ER60850	Colorado Univ., Boulder, CO (USA)	
	15:51728	DOE/ER/60850–1
FG02-90ER25084	State Univ. of New York, Stony Brook, NY (USA). Research Foundation	
	15:52583	DOE/ER/25084–T1
FG03-	General Atomics, San Diego, CA (USA)	
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FG03-84ER13257	California Univ., Riverside, CA (USA)	
	15:51775	DOE/ER/13257–T1
FG03-86ER45242		
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FG03-86ER45270		
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FG03-87ER13797	Argonne National Lab., IL (USA)	
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FG03-89ER14016	Argonne National Lab., IL (USA)	
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FG04-88ER40403	New Mexico State Univ., Las Cruces, NM (USA)	
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FG05-80ET53088	Texas Univ., Austin, TX (USA). Inst. for Fusion Studies	
	15:52355	DOE/ET/53088–455
FG05-84ER40141	Alabama Univ., University, AL (USA). Dept. of Physics and Astronomy	
	15:52009	DOE/ER/40141–8
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FG05-86ER13544		
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FG05-86ER40270	George Washington Univ., Washington, DC (USA)	
	15:52157	DOE/ER/40270–22
FG05-86ER45259	Sandia National Labs., Albuquerque, NM (USA)	
	15:51257	SAND–90-2470C
FG05-86ER75292		
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FG05-87ER40309	Rice Univ., Houston, TX (USA). Bonner Nuclear Labs.	
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FG05-87ER40330	Georgia Inst. of Tech., Atlanta, GA (USA). School of Physics	
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FG05-87ER40374	Houston Univ., TX (USA). Dept. of Physics	
	15:51505	DOE/ER/40374–38
FG05-88ER13852	Tennessee Univ., Knoxville, TN (USA)	
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	Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry	
	15:51306	DOE/ER/13852–188
FG05-88ER13893	Argonne National Lab., IL (USA)	
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FG05-88ER40435	Southeastern Universities Research Association, Newport News, VA (USA). Continuous Electron Beam Accelerator Facility	
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FG05-88ER40441	Los Alamos National Lab., NM (USA)	
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FG05-88ER45359		
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FG05-89ER14090	Maryland Univ., Baltimore, MD (USA). Dept. of Electrical Engineering	
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FG05-89ER75527	Federal Information Exchange, Inc., Germantown, MD (USA)	
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FG06-84ER60259	Alaska Univ., Fairbanks, AK (USA). Inst. of Marine Science	
	15:51727	DOE/ER/60269–T2
FG07-89ID12850	Technology Prospects, Inc., Falls Church, VA (USA)	
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	15:50300	Published article
FG22-85PC80522		North Dakota Univ., Grand Forks, ND (USA). Dept. of Chemistry
	15:50312	DOE/PC/80522--T8
FG22-85PC80529		Brigham Young Univ., Provo, UT (USA). Combustion Lab.
	15:50313	DOE/PC/80529--T14
FG22-86PC90504		Auburn Univ., AL (USA). Coal Conversion Lab.
	15:50317	DOE/PC/90504--T16
FG22-86PC90523		Oklahoma State Univ., Stillwater, OK (USA). School of Chemical Engineering
	15:50276	DOE/PC/90523--T5
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FG22-86PC90532		Texas Univ., Arlington, TX (USA). Dept. of Chemistry
	15:50318	DOE/PC/90532--15
FG22-86PC90753		Pittsburgh Univ., PA (USA). Dept. of Materials Science and Engineering
	15:50366	DOE/PC/90753--T14
FG22-87BC14126		Stanford Univ., CA (USA). Petroleum Research Inst.
	15:50446	DOE/BC/14126--27
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FG22-87PC79907		California Univ., Riverside, CA (USA). Dept. of Chemistry
	15:50307	DOE/PC/79907--T7
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FG22-87PC79912		Southern Illinois Univ., Carbondale, IL (USA). Dept. of Microbiology
	15:50268	DOE/PC/79912--12
FG22-87PC79913		Purdue Univ., Lafayette, IN (USA). Thermal Sciences and Propulsion Center
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FG22-87PC79925		Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry
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FG22-87PC79933		Utah Univ., Salt Lake City, UT (USA)
	15:50269	DOE/PC/79933--T9
FG22-88PC88912		California State Univ., Long Beach, CA (USA)
	15:50314	DOE/PC/88912--T5
FG22-88PC88920		Idaho Univ., Moscow, ID (USA). Coll. of Mines and Earth Resources
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FG22-88PC88924		Western Kentucky Univ., Bowling Green, KY (USA). Center for Coal Science
	15:50315	DOE/PC/88924--7
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FG22-88PC88929		Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering
	15:50364	DOE/PC/88929--T6
FG22-88PC88935		Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences
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FG22-88PC88937		Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering
	15:50365	DOE/PC/88937--T5
FG22-88PC88942		Wyoming Univ., Laramie, WY (USA). Dept. of Chemical Engineering
	15:50273	DOE/PC/88942--T4
FG22-89BC14449		Oklahoma Univ., Norman, OK (USA)
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W-31-109-ENG-38		International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors
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Report Number Index

The report number index consists of the alphanumeric identifiers assigned to report literature as well as patent and conference literature cited in this publication. Entries provide the abstract number; the source(s) of availability of the document; the GPO file prefix for GPO depository library documents; the order number for OSTI and NTIS report ordering purposes; and, if the document was distributed under the DOE distribution program, the category number is shown for paper copy (PC), microfiche (MF), or no distribution (ND). These categories are included to assist DOE librarians in responding to requests for reports in their collections. The index also lists secondary numbers, with the corresponding abstract numbers and cross-references to other identifying numbers.

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CONF-8604238–		(7. international workshop on photon-photon collisions; Paris (France); 1-5 Apr 1986)			
	15:52028	World Scientific Pub. Co., 687 Hartwell Street, Teaneck, NJ 07666 (USA)			
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	15:52492				
	15:52557				
	15:52558				
CONF-8905300–		(1989 multinational conference on mine planning and design; Lexington, KY (USA); 23-26 May 1989)			
	15:50352	*See* UKY-BU–151			
CONF-890604–		(Annual meeting of the American Nuclear Society; Atlanta, GA (USA); 4-8 Jun 1989)			
	15:52468				
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	15:52551				
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	15:52556				
CONF-8906186–		(Materials Research Society high energy and heavy ion beams in materials analysis workshop; Albuquerque, NM (USA); 14-16 Jun 1989)			
	15:51966	Materials Research Society, 9800 McKnight Rd., Suite 327, Pittsburgh, PA 15237 (USA)			
CONF-8906366–		(Annual conference and the 9th Canadian hydrotechnical conference; St. John's (Canada); 8-10 Jun 1989)			
	15:50680	*See* CSCE–CE03156			
CONF-8907130–		(9. international conference on vacuum ultraviolet radiation physics; Honolulu, HI (USA); 17-21 Jul 1989)			
7	15:51605	*See* LBL–28635			
CONF-890802–		(1989 synchrotron radiation instrumentation (SRI-6) national conference; Berkeley, CA (USA); 6-10 Aug 1989)			
32	15:51549	*See* LBL–28379			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8908131–		(2. LAMPF workshop on pion-nucleus double charge exchange; Los Alamos, NM (USA); 9-11 Aug 1989)			
7	15:52012	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000606	MF-414
CONF-890903–		(International Europhysics conference on high-energy physics; Madrid (Spain); 6-14 Sep 1989)			
14	15:52027	*See* SLAC-PUB–5115			
CONF-8909324–		(High energy density physics with subpicosecond laser pulses; Snowbird, UT (USA); 11-13 Sep 1989)			
	15:51452	Optical Society of America, 1816 Jefferson Place, Washington, DC 20036 (USA)			
CONF-8910423–		(Conference on physics and mechanics of cometary materials; Muenster (Germany, F.R.); 9 Oct 1989)			
	15:51899	*See* ESA-SP–302			
CONF-8910462–		(Workshop on magnetosphere-ionosphere plasma models; Huntsville, AL (USA); 11-13 Oct 1989)			
1	15:51939	*See* LA-UR–90-2968			
CONF-8910463–		(Coal structure 89 symposium; Jadwisin (Poland); 16-18 Oct 1989)			
	15:50329				
CONF-8910465–		(Workshop on the Partitioning and Transmutation of Minor Actinides; Karlsruhe, DE (USA); 16-18 Oct 1989)			
	15:50550	*See* CEA-CONF–10068			
	15:50551	*See* CEA-CONF–10069			
CONF-891092–		(3. annual topical conference on high T_c superconducting thin films: processing, characterization, and applications; Boston, MA (USA); 23-27 Oct 1989)			
	15:51217				
	15:51218				
	15:51219				
	15:51223				
CONF-891103–		(Winter meeting of the American Nuclear Society (ANS) and nuclear power and technology exhibit; San Francisco, CA (USA); 26-30 Nov 1989)			
76	15:50619	*See* WHC-SA–0649			
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
	15:51198	Materials Research Society, 9800 McKnight Rd., Suite 327, Pittsburgh, PA 15237 (USA)			
CONF-8911192–		(1989 Boulder damage symposium; Boulder, CO (USA); 1-3 Nov 1989)			
7	15:52299	*See* UCRL–101766			
CONF-8911195–		(CEC/USDOE workshop on uncertainty analysis; Santa Fe, NM (USA); 13-16 Nov 1989)			
	15:52604	*See* PNL-SA–18372			
CONF-8911225–		(21PF-1 overpack conference; Piketon, OH (USA); 14-15 Nov 1989)			
	15:50555	*See* POEF–2046			
CONF-8911226–		(Geothermal development opportunities in developing countries; Washington, DC (USA); 16 Nov 1989)			
	15:50745	*See* DOE/ID/12850–3			
CONF-8911230–		(Environmental research: technology transfer conference; Toronto (Canada); 20-21 Nov 1989)			
	15:50989	*See* OE/RT–90-03626-Vol.1			
CONF-8911236–		(Ventilation workshop; Golden, CO (USA); 13 Nov 1989)			
Vol.1	15:51062	*See* EPRI-CU–6972-Vol.1			
Vol.2	15:51063	*See* EPRI-CU–6972-Vol.2			
CONF-8911238–		(Heavy oil production and the environment. Quarterly meeting [of the] Canadian Heavy Oil Association; Calgary (Canada); 14 Nov 1989)			
	15:50522	*See* CHOA–89304ACC0387			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8911242–		(Innovations in distribution load management; Toronto (Canada); 29 Nov 1989)			
	15:50893	*See* OME–CE03083			
CONF-891163–		(21. annual symposium on optical materials for high power lasers; Boulder, CO (USA); 1-3 Nov 1989)			
4	15:52291	*See* LA-UR–90-3129			
CONF-891182–		(International conference on plasma physics; New Delhi (India); 22-28 Nov 1989)			
	15:51940	*See* TRITA-EPP–89-06			
CONF-8912104–		(142. IAU symposium on basic plasma processes on the sun; Bangalore (India); 1-5 Dec 1989)			
	15:51942	*See* TRITA-EPP–89-08			
CONF-8912118–		(1. international workshop on selected topics in theoretical physics; Hanoi (Viet Nam); Dec 1989)			
	15:52064	*See* LU-TP–90-1			
CONF-8912119–		(Yayoi symposium on quantitative non-destructive evaluation; Tokai (Japan); 4-5 Dec 1989)			
	15:51423	*See* UTNL-R–0246			
CONF-9001116–		(22. annual Lakehead University Forestry Association forestry symposium; Thunder Bay (Canada); Jan 1990)			
	15:52560	*See* BCC–CE03190			
CONF-9001118–		(Workshop on physico-mathematical study useful for effective utilization of thermal neutrons in reactor; Kumatori (Japan); 8-9 Jan 1990)			
	15:52232	*See* KURRI-TR–332			
CONF-900143–		(Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 15-19 Jan 1990)			
	15:51598				
	15:51599				
	15:51600				
37	15:51586	*See* LBL–27067			
CONF-9002118–		(1990 Lake Louise winter institute: the standards model and beyond; Lake Louise (Canada); 18-24 Feb 1990)			
3	15:52085	*See* DOE/ER/40209–11			
CONF-9002151–		(Workshop on vector dominance phenomena in the interaction of photons with hadrons and nuclei; Goettingen (Germany, F.R.); 20 Feb 1990)			
	15:52050	*See* BONN-ME–90-04			
CONF-900264–		(Topical conference on research trends in nonlinear and relativistic effects in plasmas; San Diego, CA (USA); 5-8 Feb 1990)			
8	15:51450	*See* UCRL-JC–104417			
9	15:52529	*See* UCRL–101648			
CONF-9003150–		(5. international conference on instrumentation for colliding beam physics; Novosibirsk (USSR); 15-21 Mar 1990)			
7	15:51591	*See* SLAC-PUB–5232			
CONF-9003177–		(International workshop on rare decays of light mesons; Gif-sur-Yvette (France); 29-30 Mar 1990)			
2	15:52021	*See* LA-UR–90-2984			
CONF-9003209–		(2. Feldafing international workshop; Feldafing (Germany, F.R.); 24-27 Mar 1990)			
1	15:50713	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017859	MF-401
CONF-9003215–		(Santa Fe workshop on intermittency in high energy collisions; Santa Fe, U (USA); 13 Mar 1990)			
	15:52065	*See* LU-TP–90-5			
CONF-900348–		(2. international industrial symposium on the super collider; Miami, FL (USA); 14-16 Mar 1990)			
14	15:51527	*See* BNL–43378			
15	15:51568	*See* BNL–45158			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900377–		(Energy and the environment in the 21st century; Cambridge, MA (USA); 26-28 Mar 1990)			
5	15:51642	*See* BNL–44947			
CONF-900402–		(199. national meeting of the American Ceramic Society; Boston, MA (USA); 22-27 Apr 1990)			
	15:50634				
	15:50635				
	15:51315	American Chemical Society, Distribution Dept. 408, 1155 16th St., N.W., Washington, DC 20036			
	15:51316	American Chemical Society, P.O. Box 57136, West End Station, Washington, DC 20037			
	15:51379				
	15:51690				
	15:51718				
	15:51719				
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	15:51772				
	15:51788				
CONF-9004112–		(Workshop on hadron structure functions and parton distributions; Batavia, IL (USA); 26-28 Apr 1990)			
5	15:52017	*See* FNAL/C–90/172-T			
CONF-9004133–		(American power conference; Chicago, IL (USA); 23-25 Apr 1990)			
5	15:50757	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017690	MF-101
CONF-9004181–		(DOE remedial action under the environmental restoration and waste management five-year plan; Albuquerque, NM (USA); 16-19 Apr 1990)			
Vol.1	15:50637	NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000103	MF-902
Vol.2	15:50638	NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000104	MF-902
CONF-9004243–		(IEEE international conference on robotics and automation; Sacramento, CA (USA); 7-12 Apr 1990)			
1	15:51399	*See* SAND–90-2400C			
CONF-9004246–		(Conference on prospects of hadronic physics at low energies; Zuoz (Switzerland); 7-25 Apr 1990)			
1	15:51497	*See* LA-UR–90-3322			
CONF-9004247–		(American Society for Conservation Archaeology conference; Las Vegas, NV (USA); Apr 1990)			
1	15:50941	*See* LA-UR–90-3182			
CONF-9004248–		(2. IN2-P3-RIKEN symposium on heavy-ion collisions; Obernai (France); 9-13 Apr 1990)			
	15:52162	*See* GSI–90-36(prepr.)			
CONF-900466–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
86	15:51193	*See* SAND–90-2203C			
87	15:51375	*See* LA-UR–90-3159			
89	15:51186	*See* LA-UR–90-3160			
90	15:51142	*See* UCRL–102340			
CONF-900484–		(26. annual meeting of the National Council on Radiation Protection and Measurements; Washington, DC (USA); 4-5 Apr 1990)			
3	15:51758	*See* PNL-SA–18038			
CONF-900491–		(5. international conference on accelerator mass spectrometry; Paris (France); 23-27 Apr 1990)			
	15:51532	*See* GSI–90-35(prepr.)			
CONF-9005117–		(GEOVAL '90; Stockholm (Sweden); 14-17 May 1990)			
1	15:50608	*See* SAND–89-2176			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900512–		(12. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN (USA); 7-11 May 1990)			
Absts.	15:50666	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000602	MF-249
CONF-9005145–		(International conference on frontiers of electron microscopy; Oak Brook, IL (USA); 21-24 May 1990)			
1	15:51613	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000718	MF-406
CONF-9005161–		(14. Gatlinburg actinide separations conference; Gatlinburg, TN (USA); 14-17 May 1990)			
4	15:50621	*See* WSRC-MS–90-153			
CONF-9005233–		(2. international conference on medium- and high-energy physics; Taipei (Taiwan); 8-18 May 1990)			
4	15:52013	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000607	MF-414
5	15:52203	*See* LA-UR–90-3193			
CONF-900524–		(1990 SO_2 control symposium; New Orleans, LA (USA); 8-11 May 1990)			
1	15:50773	*See* LBL–27595			
Vol.1	15:50768	*See* EPRI-GS–6963-Vol.1			
Vol.2	15:50769	*See* EPRI-GS–6963-Vol.2			
Vol.3	15:50770	*See* EPRI-GS–6963-Vol.3			
CONF-9005249–		(Confrontation between stellar pulsation and evolution; Bologna (Italy); 28-31 May 1990)			
6	15:51917	*See* LA-UR–90-3059			
CONF-900527–		(ICMC '90 topical symposium on high temperature superconductors: materials aspects; Garmisch-Partenkirchen (Germany, F.R.); 9-11 May 1990)			
4	15:51173	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017794	MF-404
CONF-9005271–		(1990 conference on hazardous waste research; Manhattan, KS (USA); 21-22 May 1990)			
1	15:51725	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90017658	MF-900
CONF-9005272–		(IAEA (International Atomic Energy Agency) advisory group meeting on experience with using the agency's model WASP for energy and nuclear power planning in developing countries; Vienna (Austria); 21-25 May 1990)			
1	15:50937	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90017862	MF-502
CONF-900528–		(International conference on organic superconductors; Lake Tahoe, CA (USA); 20-24 May 1990)			
3	15:51236	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017804	MF-401
CONF-900531–		(1. 1990 international symposium on the biological processing of coal; Orlando, FL (USA); 1-3 May 1990)			
	15:50286	*See* EPRI-GS–6970			
CONF-900557–		(8. topical conference on high-temperature plasma diagnostics; Hyannis, MA (USA); 6-10 May 1990)			
15	15:52534	*See* UCRL-JC–103285			
16	15:52356	*See* GA-A–20099			
CONF-900570–		(8. international conference on ultrarelativistic nucleus-nucleus collisions: Quark Matter '90; Menton (France); 7-11 May 1990)			
12	15:52170	*See* UCRL-JC–104781			
CONF-900572–		(Hazardous material spills conference: prevention-preparedness-response; Houston, TX (USA); 13-17 May 1990)			
1	15:51644	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017801	MF-407
CONF-900601–		(12. PANIC international conference on particles and nuclei; Cambridge, MA (USA); 24-29 Jun 1990)			
10	15:51575	*See* SLAC-PUB–5331			
12	15:52023	*See* LBL–29347			
13	15:52155	*See* BNL–45211			
CONF-900603–		(2. European particle accelerator conference; Nice (France); 11-16 Jun 1990)			
37-Extd.Abst.	15:51498	*See* LBL–29114-Extd.Abst.			
38	15:51505	*See* DOE/ER/40374–38			

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CONF-900607–		(Advances in human factors research on man-computer interactions: nuclear and beyond; Nashville, TN (USA); 10-15 Jun 1990)			
1	15:50850	*See* PNL-SA–17301			
CONF-900608–		(American Nuclear Society annual meeting; Nashville, TN (USA); 10-14 Jun 1990)			
Absts.	15:52545	*See* UCRL-JC–104849			
CONF-9006105–		(28. symposium on engineering aspects of magnetohydrodynamics; Chicago, IL (USA); 26-28 Jun 1990)			
10	15:51030	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000015	MF-112
CONF-9006134–		(Workshop on global climate feedbacks; Upton, NY (USA); 4-6 Jun 1990)			
1	15:51643	*See* BNL–45190			
CONF-9006184–		(1990 Government-industry technical symposium; Williamsburg, VA (USA); 12-14 Jun 1990)			
3	15:51634	*See* SAND–89-3015C			
CONF-9006194–		(11. international science and technology symposium; Seoul (Republic of Korea); 25-29 Jun 1990)			
2	15:51773	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017795	MF-408
CONF-9006203–					
	15:52317	*See* BONN-AM–90-05			
CONF-9006220–		(28. COSPAR plenary conference; The Hague (Netherlands); 25 Jun - 6 jul 1990)			
4	15:51843	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017792	MF-407
5	15:52543	*See* UCRL-JC–104418			
CONF-900623–		(15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990)			
20	15:52496	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000554	MF-423
21	15:52497	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000705	MF-423
CONF-9006242–		(Workshop on short pulse high current cathodes; Bendor (France); 18-22 Jun 1990)			
2	15:51546	*See* LA-UR–90-3180			
CONF-9006243–		(8. beta battery workshop; Chester (UK); 12-18 Jun 1990)			
2	15:50916	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017668	MF-212
CONF-900626–		(2. international conference on advanced technology and particle physics; Como (Italy); 11-15 Jun 1990)			
2	15:51592	*See* SLAC-PUB–5248			
CONF-9006267–		(1990 DPF summer study on high energy physics; Snowmass, CO (USA); 25 Jun - 13 jul 1990)			
4	15:52018	*See* IS-M–653			
5	15:52058	*See* IS-M–651			
6	15:52059	*See* IS-M–652			
CONF-9006268–		(10. international conference on physics in collision; Durham, NC (USA); 21-23 Jun 1990)			
2	15:52063	*See* LBL–29466			
3	15:52015	*See* FNAL/C–90/159-E			
4	15:52016	*See* FNAL/C–90/165-E			
CONF-9006271–		(NATO advanced research workshop on methods and mechanisms for producing ions from large molecules: Ontario (Canada); 24-28 Jun 1990)			
1	15:51283	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017808	MF-401
2	15:51284	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000393	MF-406; MF-408
CONF-9006272–		(18. international colloquium on group theoretical methods in physics; Moscow (USSR); 4-9 Jun 1990)			
1	15:52269	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017814	MF-404
CONF-9006273–		(14. workshop on condensed matter theories; Elba (Italy); 18-23 Jun 1990)			
1	15:51237	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017811	MF-404
CONF-9006275–		(Workshop on physics and detector issues for a high-luminosity asymmetric B factory; Stanford, CA (USA); 4-8 Jun 1990)			
1	15:52071	*See* SLAC-PUB–5323			

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CONF-9006276--		(14. international conference on neutrino physics and astrophysics; Cern (Switzerland); 10-15 Jun 1990)			
1	15:52022	*See* LA-UR-90-3359			
CONF-9006281--		(Particle correlations and interferometry in nuclear collisions; Nantes (France); 28-30 Jun 1990)			
1-Vugraphs	15:52177	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000716	MF-413
CONF-900631--		(International conference on pollution prevention: clean technologies and clean products--the environmental challenge of the 1990's; Washington, DC (USA); 10-13 Jun 1990)			
5	15:50609	*See* SAND-89-2952C			
CONF-900643--		(IEEE international symposium on applications of ferroelectrics; Urbana, IL (USA); 6-8 Jun 1990)			
2	15:51174	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017684	MF-364
CONF-9007105--		(Institute of nuclear materials management conference; Los Angeles, CA (USA); 15-18 Jul 1990)			
67	15:50642	*See* PNL-SA-18423			
71	15:50636	*See* BNL-44984			
73	15:50545	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90017824	MF-515
74	15:50641	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90017835	MF-515
CONF-9007136--		(1990 summer workshop on nonlinear and chaotic phenomena in plasmas, solids, and fluids; Edmonton (Canada); 16-27 Jul 1990)			
4	15:52006	*See* LA-UR-90-3311			
CONF-9007149--		(39. annual Denver x-ray conference; Steamboat Springs, CO (USA); 30 Jul - 3 aug 1990)			
3	15:51294	*See* LBL-29360			
CONF-9007157--		(SPIE conference on EUV x-ray and gamma-ray instrumentation for astronomy; San Diego, CA (USA); 8-13 Jul 1990)			
2	15:52289	*See* LA-UR-90-2975			
3	15:51551	*See* LBL-29490			
CONF-9007171--		(1. workshop on a TeV superconducting linear collider; Ithaca, NY (USA); 23-26 Jul 1990)			
1	15:51517	*See* SLAC-PUB-5328			
CONF-9007172--		(MAXENT '90: maximum entropy workshop; Laramie, WY (USA); 30 Jul - 3 aug 1990)			
1	15:52171	*See* LA-UR-90-3253			
2	15:52343	*See* LA-UR-90-3249			
CONF-900724--		(5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990)			
9	15:51679	*See* PNL-SA-18282			
CONF-900756--		(SPIE's international symposium on optical and optoelectronic applied science and engineering exhibit; San Diego, CA (USA); 8-13 Jul 1990)			
42	15:51529	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017818	MF-404
43	15:51607	*See* SAND-90-2419C			
44	15:51604	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000561	
45	15:51926	*See* UCRL-JC-104996			
47	15:51550	*See* LBL-29464			
48	15:51594	*See* UCRL-JC-104995			
49	15:51593	*See* UCRL-JC-104994			
50	15:51632	*See* UCRL-102576			
CONF-900766--		(1. biennial conference on low energy antiproton physics; Stockholm (Sweden); 2-6 Jul 1990)			
3	15:52224	*See* SLAC-PUB-5343			
CONF-900772--		(4. workshop on experiments and detectors for a relativistic heavy ion collider; Upton, NY (USA); 2-7 Jul 1990)			
5	15:52024	*See* LBL-29488			
CONF-900791--		(Review of progress in quantitative NDE; La Jolla, CA (USA); 15-20 Jul 1990)			
4	15:51421	*See* LA-UR-90-2988			

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CONF-900801–		(25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990)			
27	15:50481	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017664	MF-310
28	15:51088	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017671	MF-310
30	15:50936	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017682	MF-400
31	15:51438	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017864	MF-364
CONF-900802–		(200. American Chemical Society national meeting; Washington, DC (USA); 26-31 Aug 1990)			
8	15:50654	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017816	MF-401
9	15:50305	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017803	MF-401
CONF-900806–		(19. international conference on low temperature physics; Brighton (UK); 16-22 Aug 1990)			
10	15:52308	*See* BNL–45146			
CONF-900807–		(Joint Varenna-Lausanne international workshop on theory of fusion plasmas; Varenna (Italy); 27-31 Aug 1990)			
1	15:52370	*See* LA-UR–90-3345			
CONF-900809–		(21. DOE/NRC nuclear air cleaning conference; San Diego, CA (USA); 13-16 Aug 1990)			
4	15:51388	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017796	MF-502
CONF-9008116–		(International symposium on radiation effects on polymeric materials - satellite symposium to the 200th national meeting of the American Chemical Society; Washington, DC (USA); 26-31 Aug 1990)			
1	15:51774	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000559	MF-408
CONF-900814–		(7. ASTM-EURATOM symposium on reactor dosimetry; Strasbourg (France); 27-31 Aug 1990)			
6	15:51590	*See* SAND–90-2072C			
14	15:52516	*See* PNL-SA–18521			
CONF-9008140–		(AIChE summer meeting; San Diego, CA (USA); 19-22 Aug 1990)			
2	15:50453	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017683	MF-254
CONF-9008153–		(Political science association annual meeting on global climate problems and public policy; San Francisco, CA (USA); 29 Aug - 2 sep 1990)			
1	15:50948	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017316	MF-400; MF-402
CONF-9008155–		(American Statistical Association (ASA) conference on statistics and national security; Anaheim, CA (USA); 6-8 Aug 1990)			
1	15:51115	*See* LA-UR–90-3241			
CONF-9008156–		(5. ICSRIC-90: international conference on systems research, informatics and cybernetics; Baden-Baden (German Democratic Republic); 6-12 Aug 1990)			
1	15:52590	*See* LBL–29301			
CONF-9008157–		(ANS workshop on mechanistic analyses involving aerosols in non-reactor facility accidents; Salt Lake City, UT (USA); 2-3 Aug 1990)			
1	15:51683	*See* UCRL-JC–104134			
CONF-9008159–		(Conference on parallel computation for reaction dynamics; Perugia (Italy); 30 Aug - 1 sep 1990)			
1	15:52342	*See* LA-UR–90-3055			
CONF-9008161–		(Workshop on methods of analysis and interpretation of neutron reflectivity data; Argonne, IL (USA); 23-25 Aug 1990)			
1	15:52233	*See* LA-UR–90-3127			
CONF-900818–		(International conference on shock wave and high-strain-rate phenomena in materials; San Diego, CA (USA); 12-17 Aug 1990)			
6	15:51197	*See* UCRL-JC–106066			
CONF-900822–		(25. IUPAP international conference on high energy physics; Singapore (Singapore); 2-8 Aug 1990)			
	15:52025	*See* MPI-PAE/Exp.El.–227			
	15:52066	*See* MPI-PAE/Exp.El.–230			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
10	15:52011	*See* ANL-HEP-CP–90-49			
CONF-900833–		(ACEEE summer study on energy efficiency in buildings; Pacific Grove, CA (USA); 26 Aug - 1 sep 1990)			
8	15:51023	*See* PNL-SA–18484			
9	15:51075	*See* PNL-SA–18422			
10	15:51076	*See* PNL-SA–18447			
11	15:51022	*See* PNL-SA–17700			
12	15:51074	*See* PNL-SA–17701			
CONF-900846–		(International symposium to commemorate the 50th anniversary of discovery of transuranium elements; Washington, DC (USA); 26-31 Aug 1990)			
2	15:52167	*See* LBL–29445			
3	15:51253	*See* LBL–29305			
4	15:51310	*See* LA-UR–90-3264			
CONF-900853–		(Gasification and gas stream cleanup systems; Morgantown, WV (USA); 28-30 Aug 1990)			
4	15:50295	*See* UCRL-JC–104514			
CONF-900857–		(Mikolajki summer school on nuclear physics: nuclear and atomic physics with accelerators of the nineties; Mikolajki (Poland); 26 Aug - 5 sep 1990)			
1	15:52223	*See* LBL–29482			
CONF-900874–		(1990 international conference on parallel processing; St. Charles, IL (USA); 13-17 Aug 1990)			
4	15:52603	*See* PNL-SA–17937			
CONF-900877–		(12. international congress for electron microscopy; Seattle, WA (USA); 12-18 Aug 1990)			
6	15:51612	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017799	MF-406
8	15:51791	*See* BNL–44480			
CONF-900903–		(8. general conference of the European Physical Society; Amsterdam (Netherlands); 4-8 Sep 1990)			
1	15:51589	*See* PNL-SA–18025			
CONF-9009100–		(SPIE's technical symposium on microelectronic processing integration and exhibition as part of SPIE's thematic applied science and engineering series; Santa Clara, CA (USA); 30 Sep - 5 oct 1990)			
1	15:51194	*See* SAND–90-2333C			
CONF-9009110–		(Joint ANS/ASME nuclear engineering conference; Newport, RI (USA); 16-20 Sep 1990)			
3	15:50615	*See* UCRL-JC–103679			
CONF-9009113–		(SAE international off-highway and power plant congress and exposition; Milwaukee, WI (USA); 10-13 Sep 1990)			
1	15:51103	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017660	MF-335
CONF-9009123–		(Linear accelerator conference; Albuquerque, NM (USA); 9-14 Sep 1990)			
4	15:51523	*See* UCRL-JC–103795			
6	15:51555	*See* SSCL–311			
7	15:51561	*See* UCRL-JC–105054			
8	15:51548	*See* LA-UR–90-3371			
9	15:51514	*See* LA-UR–90-3372			
10	15:51556	*See* SSCL–312			
11	15:51557	*See* SSCL–313			
12	15:51494	*See* LA-UR–90-3096			
13	15:51545	*See* LA-UR–90-3099			
14	15:51510	*See* LA-UR–90-3144			
15	15:51509	*See* LA-UR–90-3081			
16	15:51547	*See* LA-UR–90-3296			
17	15:51544	*See* LA-UR–90-3094			
18	15:51515	*See* LBL–28870			
19	15:51493	*See* LA-UR–90-3082			
20	15:51560	*See* UCRL-JC–105043			
21	15:51558	*See* UCRL–103780			
22	15:51511	*See* LA-UR–90-3175			
23	15:51512	*See* LA-UR–90-3176			

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24	15:51491	*See* BNL–45171			
25	15:51508	*See* LA-UR–90-3052			
26	15:51524	*See* UCRL-JC–103796			
27	15:51559	*See* UCRL-JC–103784			
28	15:51525	*See* UCRL-JC–103804			
29	15:51520	*See* UCRL-JC–103785			
30	15:51500	*See* UCRL-JC–103788			
31	15:51521	*See* UCRL-JC–103786			
32	15:51519	*See* SLAC-PUB–5339			
33	15:51554	*See* SLAC-PUB–5345			
34	15:51499	*See* SSCL–310			
35	15:51522	*See* UCRL-JC–103790			
CONF-9009135–		(International conference on high spin physics and gamma-soft nuclei; Pittsburgh, PA (USA); 17-21 Sep 1990)			
2	15:52222	*See* LA-UR–90-3335			
CONF-9009161–		(15. world conference of the International Nuclear Target Development Society: special high-purity materials and targets; Santa Fe, NM (USA); 10-14 Sep 1990)			
1	15:51918	*See* LA-UR–90-3072			
CONF-9009166–		(12. international free electron laser conference (FEL-12); Paris (France); 17-21 Sep 1990)			
4	15:51492	*See* LA-UR–90-2932			
5	15:51495	*See* LA-UR–90-3138			
6	15:51501	*See* UCRL-JC–104102			
CONF-900917–		(American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990)			
16	15:50792	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90017825	MF-535
17	15:50874	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000724	MF-400
CONF-9009173–		(SPIE conference on prospects on high temperature superconducting transistors and other devices; Santa Clara, CA (USA); 30 Sep - 5 oct 1990)			
1	15:51180	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000721	MF-404
CONF-9009174–		(5. international symposium on resonance ionization spectroscopy and its applications; Varese (Italy); 16-21 Sep 1990)			
5	15:51290	*See* LA-UR–90-3247			
CONF-900918–		(16. symposium on fusion technology; London (UK); 3-7 Sep 1990)			
6	15:52544	*See* UCRL-JC–104573			
7	15:52352	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000395	MF-420
8	15:52510	*See* LA-UR–90-2974			
9	15:52509	*See* LA-UR–90-2938			
CONF-9009200–		(1990 LINAC conference; Albuquerque, NM (USA); 10-14 Sep 1990)			
12	15:51518	*See* SLAC-PUB–5330			
15	15:51528	*See* BNL–44624			
16	15:51542	*See* LA-UR–90-3043			
17	15:51543	*See* LA-UR–90-3046			
CONF-9009201–		(Radioluminescent technology conference; Annapolis, MD (USA); 25-26 Sep 1990)			
6	15:51398	*See* SAND–90-2320C			
CONF-9009225–		(Committee on safety of nuclear installations (CSNI); Santa Fe, NM (USA); 4-6 Sep 1990)			
3-Draft	15:50851	*See* SAND–90-2378C-Draft			
CONF-9009241–		(1990 ASPE (American society of photoptical engineers) annual conference; Rochester, NY (USA); 23-28 Sep 1990)			
1	15:51143	*See* UCRL–102697			
CONF-9009249–		(MTS '90; Washington, DC (USA); 26-28 Sep 1990)			
1	15:50729	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017665	MF-262
CONF-9009254–		(International conference on calibration and reliability in groundwater modeling; Hague (Netherlands); 3-6 Sep 1990)			
1	15:51726	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017737	MF-402

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CONF-9009257–		(International conference on science and technology of synthetic metals; Tuebingen (Germany, F.R.); 2-7 Sep 1990)			
1	15:51257	*See* SAND–90-2470C			
2	15:52292	*See* LA-UR–90-3329			
CONF-9009258–		(Modeling of casting, welding and advanced solidification processes engineering foundation conference; Davos (Switzerland); 16-21 Sep 1990)			
1	15:51139	*See* SAND–90-0449C			
CONF-9009259–		(Apollo domain users' society workstation conference; San Diego, CA (USA); 30 Sep - 4 oct 1990)			
1	15:52606	*See* SAND–90-1813C			
CONF-900926–		(5. international conference on multiphoton processes; Paris (France); 24-28 Sep 1990)			
1	15:51960	*See* LA-UR–90-3210			
2	15:51959	*See* LA-UR–90-3133			
3	15:51949	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000641	MF-406
CONF-9009261–		(Workshop on fast ion collisions; Debrecen (Hungary); 17-19 Sep 1990)			
1	15:51951	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000555	MF-414
2	15:52270	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000725	MF-414
3	15:52271	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000736	MF-411
CONF-9009264–		(Conference on the effect of irradiation on materials of fusion reactors; Leningrad (USSR); 18-20 Sep 1990)			
1	15:52500	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000390	MF-420
CONF-9009265–		(School on symmetry and structural properties on condensed matter; Poznan (Poland); 6-12 Sep 1990)			
1	15:52341	*See* LA-UR–90-2947			
CONF-9009266–		(2. international colloquium on x-ray lasers; York (UK); 17-21 Sep 1990)			
1-Vugraphs	15:51451	*See* UCRL-JC–104983			
CONF-9009267–		(Physical and chemical mechanisms in molecular radiation biology conference; Woods Hole, MA (USA); 3-7 Sep 1990)			
1	15:51952	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000732	MF-411
CONF-9009271–		(AR&TD direct utilization and instrumentation and diagnostics contractors' review meeting; Pittsburgh, PA (USA); 16-18 Sep 1990)			
1-Vugraphs	15:50332	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000645	MF-114
CONF-900936–		(7. international conference on ion beam modification of materials; Knoxville, TN (USA); 9-14 Sep 1990)			
7	15:51140	*See* SAND–90-0993C			
9	15:52240	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000394	MF-410
10	15:51122	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000708	MF-404
CONF-900944–		(Applied superconductivity conference; Aspen, CO (USA); 24-28 Sep 1990)			
3	15:51184	*See* EGG–10617-2017			
5	15:51196	*See* UCRL-JC–105046			
6	15:51449	*See* UCRL-JC–103598			
7	15:52528	*See* UCRL–100531			
8	15:52535	*See* UCRL-JC–103490			
9	15:52536	*See* UCRL-JC–103596			
10	15:51170	*See* BNL–45207			
11	15:51172	*See* BNL–45227			
12	15:51171	*See* BNL–45208			
CONF-900977–		(Spectrum '90: American Nuclear Society (ANS) international meeting on radioactive waste technologies, decontamination, and hazardous wastes; Knoxville, TN (USA); 30 Sep - 4 oct 1990)			
2	15:50622	*See* WSRC-RP–89-1409			
CONF-900981–		(Advanced research and technology development contractors review; Pittsburgh, PA (USA); 16-19 Sep 1990)			
1	15:50306	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017823	MF-115

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CONF-900982--		(Direct liquefaction contractors review; Pittsburgh, PA (USA); 24-27 Sep 1990)			
1	15:50294	*See* SAND--90-2198C			
CONF-901004--		(Conference on magnetism and magnetic materials; San Diego, CA (USA); 30 Oct - 2 nov 1990)			
5	15:51130	*See* LA-UR--90-3166			
6	15:51242	*See* LA-UR--90-3170			
CONF-901007--		(9. topical meeting on technology of fusion energy; Oak Brook, IL (USA); 7-11 Oct 1990)			
3	15:52511	*See* LA-UR--90-3246			
4	15:52512	*See* LA-UR--90-3261			
5	15:52541	*See* UCRL-JC--103938			
6	15:52538	*See* UCRL-JC--103816			
7	15:52540	*See* UCRL-JC--103818			
8	15:52546	*See* UCRL-JC--105033			
9	15:52539	*See* UCRL-JC--103817			
10	15:52537	*See* UCRL-JC--103815			
11	15:52531	*See* UCRL-CR--103909			
12	15:52530	*See* UCRL-CR--103908			
14	15:52532	*See* UCRL-CR--103910			
CONF-901008--		(Fall meeting of the Minerals, Metals and Materials Society on physical metallurgy and materials in conjunction with materials week and the material applications and services exposition; Detroit, MI (USA); 7-11 Oct 1990)			
2	15:51135	*See* LBL--29184			
3	15:51136	*See* LBL--29185			
4	15:51131	*See* LA-UR--90-3347			
CONF-9010166--		(6. annual Department of Energy model conference on waste management and environmental restoration; Oak Ridge, TN (USA); 29 Oct - 2 nov 1990)			
3	15:50595	*See* LA-UR--3229			
4-Vugraphs	15:50564	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000710	MF-721
CONF-9010172--		(61. shock and vibration symposium; Pasadena, CA (USA); 16-18 Oct 1990)			
4	15:51616	*See* SAND--90-1579C			
5	15:51629	*See* SAND--90-1575C			
CONF-9010173--		(7. DOE-PETC/AIST-NEDO joint technical meeting; New Orleans, LA (USA); 8-12 Oct 1990)			
2	15:50656	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000726	MF-108
CONF-9010193--		(Annual automotive technology development contractor coordination meeting; Dearborn, MI (USA); 22-25 Oct 1990)			
3	15:51104	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000737	MF-336
CONF-9010195--		(ESORICS '90; Toulouse (France); 24-26 Oct 1990)			
1	15:52587	*See* LA-UR--90-3145			
CONF-9010197--		(American flame research committee 1990 fall international symposium; San Francisco, CA (USA); 8-10 Oct 1990)			
1	15:51376	*See* UCRL-JC--104065			
CONF-9010198--		(Ecological indicators conference; Ft. Lauderdale, FL (USA); 16-19 Oct 1990)			
1	15:51640	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000586	MF-402
CONF-9010199--		(Advisory group meeting on intermediate energy nuclear data for applications; Vinna (Austria); 9-12 Oct 1990)			
1	15:52225	*See* UCRL-JC--104986			
CONF-9010200--		(IAEA specialists meeting on nuclear power plant lifetime assurance; Stockholm (Sweden); 10-13 Oct 1990)			
1	15:50787	*See* SAND--90-2128C			
CONF-9010201--		(37. Sagamore army materials research conference; Plymouth, MA (USA); 1-4 Oct 1990)			
1	15:51181	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000618	MF-332
CONF-9010202--		(8. 1990 annual membrane technology/planning conference and 1. high-tech separations symposium; Newton, MA (USA); 15-17 Oct 1990)			
1	15:50620	*See* WHC-SA--0993			

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CONF-9010203–		(Deburring salon conference; Nagoya (Japan); 23-25 Oct 1990)			
1	15:51091	*See* KCP–613-4437			
CONF-9010207–		(1990 combustion institute fall meeting; San Diego, CA (USA); 14-16 Oct 1990)			
1	15:50890	*See* SAND–90-2251C			
CONF-9010209–		(Workshop on physics of alternative magnetic confinement schemes; Varenna (Italy); 14-15 Oct 1990)			
1	15:52542	*See* UCRL-JC–104182			
CONF-901025–		(13. international conference on plasma physics and controlled nuclear fusion research; Washington, DC (USA); 1-6 Oct 1990)			
9	15:52359	*See* IAEA-CN–53/E-3-11			
10	15:52502	*See* IAEA-CN–53/F-2-2			
CONF-901035–		(37. national American Vacuum Society symposium; Toronto (Canada); 8-12 Oct 1990)			
1	15:51129	*See* LA-UR–90-3048			
2	15:51141	*See* SAND–90-1470C			
3	15:52533	*See* UCRL-JC–101185			
4	15:51195	*See* UCRL-JC–103668			
CONF-901053–		(Fall conference of the American Society for Nondestructive Testing; Seattle, WA (USA); 9-12 Oct 1990)			
1	15:51614	*See* KCP–613-4426			
CONF-901057–		(7. international symposium on capture gamma-ray spectroscopy and related topics; Pacific Grove, CA (USA); 14-19 Oct 1990)			
2	15:52204	*See* BNL–45195			
CONF-901101–		(American Nuclear Society winter meeting; Washington, DC (USA); 11-15 Nov 1990)			
34	15:50552	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000715	MF-526
CONF-901105–		(Fall meeting of the Materials Research Society; Boston, MA (USA); 24 Nov - 1 dec 1990)			
10	15:50563	NTIS, PC A; OSTI; INIS; GPO Dep.	E 1.99:	DE90017760	
12	15:51187	*See* LA-UR–90-3268			
13	15:51259	*See* UCRL-JC–104279			
14	15:52290	*See* LA-UR–90-2976			
15	15:52298	*See* SAND–90-1772C			
CONF-901106–		(Fuel cell seminar; Phoenix, AZ (USA); 26-28 Nov 1990)			
1	15:51108	*See* LA-UR–90-3356			
CONF-901109–		(International symposium on gas-liquid two-phase flows in conjunction with the winter annual meeting of the American Society of Mechanical Engineers; Dallas, TX (USA); 25-30 Nov 1990)			
20	15:51080	*See* SERI/TP–254-3800			
CONF-9011110–		(DOE workshop on advanced laser technology for chemical measurements; Oak Ridge, TN (USA); 12-14 Nov 1990)			
1	15:51285	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000614	MF-406
2	15:51286	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000613	MF-401
3	15:51287	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000621	MF-406
CONF-901116–		(11. international conference on the application of accelerators in research and industry; Denton, TX (USA); 5-8 Nov 1990)			
1	15:52172	*See* LA-UR–90-3346			
2	15:51496	*See* LA-UR–90-3315			
3	15:52513	*See* LA-UR–90-3331			
4	15:52344	*See* LA-UR–90-3344			
5	15:51513	*See* LA-UR–90-3293			
7	15:51569	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000625	MF-411
8	15:52241	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000622	MF-414
9	15:52498	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000707	MF-421
10	15:51950	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000706	MF-411
11	15:51638	*See* BNL–45225			

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CONF-901125–		(2. international ceramic science and technology congress symposium on glasses for electronic applications; Orlando, FL (USA); 12-15 Nov 1990)			
1	15:51175	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000399	MF-404
CONF-901191–		(11. annual national conference and exhibition of the Hazardous Materials Control Research Institute: superfund '90; Washington, DC (USA); 26-28 Nov 1990)			
1	15:50939	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000624	MF-400
CONF-901194–		(ASME winter annual meeting; Dallas, TX (USA); 25-30 Nov 1990)			
3	15:51176	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017832	MF-364
COO–					
2197-122	15:51954	*See* DOE/ER/40333–T3			
CP/PQ–					
50	15:51694	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CPA–					
90-04408	15:50456	PC Canadian Petroleum Association, 3800 - 150 6th. Ave. S.W., Calgary, AB, CAN T2P 3Y7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
CPE–					
45952Q	15:50394	PC Int'l Focus Res. Inc., 1210, 815 - 8th Avenue SW, Calgary, AB, CAN T2P 3P2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CPIA-VT–					
02	15:50655	*See* PB–90-780610/XAB			
CRDEC-TR–					
179	15:51639	*See* AD-A–223374/0/XAB			
CREDA–					
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DOE/PC/89866–					
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DOE/PC/89909–					
T2	15:50261	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000011	MF-102
DOE/PC/90013–					
T13	15:50275	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000985	MF-108
DOE/PC/90504–					
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DOE/PC/90523–					
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T6	15:50277	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000632	MF-108
DOE/PC/90532–					
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DOE/PC/91257–					
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90-24-Vol.3	15:50568	NTIS, PC A19/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000565	MF-510
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T4-Vol.1	15:51059	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000110	MF-350
DOT/FRA/ORD–					
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DP-MS–					
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DPAG–					
68-2/1-1OE	15:51089	PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
DSPC–					
67084H-A	15:50473	PC Ogy Petroleums Ltd., 505 - 500 Fourth Avenue SW, Calgary, AB, CAN T2P 2V6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
67084H-B	15:50474	PC Ogy Petroleums Ltd., 505 - 500 Fourth Avenue SW, Calgary, AB, CAN T2P 2V6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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DTH-LV-R–					
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DTRC-SME–					
89/100	15:51169	*See* AD-A–223494/6/XAB			
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741/CDF	15:52015	*See* FNAL/C–90/159-E			

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90-03090	15:51011	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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33	15:50994	PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $18.00 CAN; MF $10 CAN			
EC–					
90-03115	15:50949	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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10617-2017	15:51184	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000129	MF-706
2597	15:51254	*See* NUREG/CR–5542			
2603	15:50602	*See* NUREG/CR–5594			
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450/4-89/010	15:51665	*See* PB–90-255415/XAB			
450/4-89/012	15:51671	*See* PB–90-256777/XAB			
520/1-90/015	15:51854	*See* PB–90-262114/XAB			
520/1-90/016	15:51713	*See* PB–90-262122/XAB			
540/8-89/006	15:50982	*See* PB–90-258484/XAB			
600/D-90/104	15:51677	*See* PB–90-262833/XAB			
600/D-90/106	15:51676	*See* PB–90-262817/XAB			
9200.0-03A	15:50975	*See* PB–90-249434/XAB			
9200.3-08	15:50976	*See* PB–90-249467/XAB			
9200.5-302	15:50981	*See* PB–90-258310/XAB			
9320.1-09	15:50977	*See* PB–90-249608/XAB			
9347.1-02	15:51709	*See* PB–90-249640/XAB			
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12312-EN	15:50340	Commission of the European Communities, Luxembourg			
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12325-EN	15:50342	Commission of the European Communities, Luxembourg			
12349-FR	15:50287	Commission of the European Communities, Luxembourg			
12350-IT	15:50288	Commission of the European Communities, Luxembourg			
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12385	15:52563	NTIS (US Sales Only), PC A11/MF A01			
12423	15:50759	NTIS (US Sales Only), PC A12/MF A01; OSTI; Office for Official Publications of the European Communities, 2, rue Mercier, L-2985 Luxembourg; Price ECU 21.25		TI90017777	
12453	15:50751	NTIS (US Sales Only), PC A; OSTI; Office for Official Publications of the European Communities 2, rue Mercier L-2985 Luxembourg; Price ECU 6.25		TI90017783	
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12511-EN	15:50344	Commission of the European Communities, Luxembourg			
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12519-FR	15:50346	Commission of the European Communities, Luxembourg			
12545-DE	15:50347	Commission of the European Communities, Luxembourg			
12628-FR	15:50290	Commission of the European Communities, Luxembourg			
12644-FR	15:50291	Commission of the European Communities, Luxembourg			
12652-EN	15:50304	Commission of the European Communities, Luxembourg			
12656-EN	15:50348	Commission of the European Communities, Luxembourg			
12658-EN	15:50349	Commission of the European Communities, Luxembourg			
12662-ES	15:50350	Commission of the European Communities, Luxembourg			
13044-EN	15:52604	*See* PNL-SA–18372			
FC–					
12-10	15:50659	PC Petawawa National Forestry Institute, Distribution Centre, P.O. Box 2000, Chalk River, ON, CAN K0J 1J0; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
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106-14/1989	15:50951	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			

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1965	15:50840	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604585	
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88-3	15:50952	Available from Freie Univ. Berlin (Germany, F.R.). Forschungsstelle fuer Umweltpolitik			
FNAL/C–					
90/159-E	15:52015	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000831	MF-414
90/165-E	15:52016	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000894	MF-414
90/172-T	15:52017	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000363	MF-414
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89/E/60	15:51733	NTIS (US Sales Only), PC A03/MF A01		DE91706217	
90/E/1	15:52561	NTIS (US Sales Only), PC A03/MF A01		DE91706219	
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4694	15:51233	*See* AD-A–223339/3/XAB			
GL-TR–					
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90-0164	15:51897	*See* AD-A–223428/4/XAB			
90-0166	15:51935	*See* AD-A–223627/1/XAB			
90-0177	15:51938	*See* AD-A–223850/9/XAB			
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R71-19/54-1988E	15:50482	PC Indian and Northern Affairs Canada, Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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HCR-CDTN–					
13	15:51840	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604236	
HIFAN–					
458	15:51515	*See* LBL–28870			
HMRL-R–					
73:4	15:50758	*See* DOE/CE/15453–T4			
HQ–					
CE03147	15:50756	Hydro-Quebec, Centre de diffusion, 75, boul. Dorchester ouest, 14e etage, Montreal, PQ, CAN H2Z 1A4. Prices: N/C			
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13314B	15:50841	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
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13402B	15:50837	Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
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4841-3	15:50843	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604598	
4900-7	15:52358	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602909	
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53/F-2-2	15:52502	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000713	MF-420
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89/281	15:52318	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602693	
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90/108	15:52331	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602708	
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90/112	15:52333	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602697	
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90/142	15:52104	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602736	
90/143	15:52338	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602721	
90/44	15:52319	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602722	
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90/95	15:52276	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602866	
90/96	15:52102	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602737	
90/99	15:52327	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602710	
ICA–					
3	15:50752	Copy held by UB/TIB Hannover			
7	15:50753	Copy held by UB/TIB Hannover			
IEACR–					
26	15:50380	IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom			
29	15:50325	IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom			
IFSR–					
455	15:52355	*See* DOE/ET/53088–455			
IFVE-ONF–					
89-46	15:51440	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604781	
INIS-mf–					
12120	15:51792	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706221	
12121	15:51793	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90706222	
12122	15:51794	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706223	
12123	15:51795	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90706224	
12125	15:51796	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90706225	
12126	15:51797	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90706226	
12127	15:51798	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90706227	
12129	15:51799	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90706228	
INP–					
1377/PL	15:52279	NTIS (US Sales Only), PC A14/MF A01; OSTI; INIS		DE91602823	
1388/AP	15:51700	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604877	
1397/AP	15:51883	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91604878	
1403/AP	15:51701	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91604879	
1407/AP	15:50877	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91604241	
1412/AP	15:51702	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604140	
1414/PS	15:52208	NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS		DE91603094	
INS–					
824	15:51535	NTIS (US Sales Only), PC A02/MF A01		DE91712925	
825	15:51536	NTIS (US Sales Only), PC A02/MF A01		DE91712924	
829	15:52339	NTIS (US Sales Only), PC A03/MF A01		DE91712982	
830	15:51957	NTIS (US Sales Only), PC A03/MF A01		DE91712983	
832	15:52056	NTIS (US Sales Only), PC A03/MF A01		DE91713079	
833	15:52057	NTIS (US Sales Only), PC A03/MF A01		DE91713078	
834	15:52173	NTIS (US Sales Only), PC A03/MF A01		DE91713084	
835	15:52218	NTIS (US Sales Only), PC A05/MF A01		DE91713085	
INT–					
194/I	15:50649	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE91604461	
IPP–					
5/34	15:52360	NTIS (US Sales Only), PC A04/MF A01		DE91706328	
5/35	15:52361	NTIS (US Sales Only), PC A03/MF A01		DE91706329	
IS–					
5002	15:51288	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017261	MF-515
IS-IPRT–					
7	15:51884	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000572	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
IS-M–					
651	15:52058	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000084	PC-414
652	15:52059	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000085	PC-414
653	15:52018	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000083	PC-414
IS-T–					
1410	15:52310	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000662	MF-411
1416	15:51128	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000199	MF-401
1420	15:52019	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000609	MF-414
1445	15:51239	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000742	MF-404
1446	15:52060	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000195	MF-414
1448	15:51185	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000743	MF-411
1455	15:50292	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000744	MF-102
1457	15:51240	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000201	MF-404
1458	15:51584	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000749	MF-414
1460	15:50367	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000663	MF-103
ITEF–					
66-89	15:50854	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604731	
71-89	15:52362	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602935	
ITP–					
88-121	15:52106	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602739	
IWD/AR/WQB–					
89-152	15:51734	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
JA–					
6402	15:51435	*See* AD-A–223714/7/XAB			
JAERI-M–					
90-048	15:50788	NTIS (US Sales Only), PC A11/MF A01		DE91712914	
90-078	15:50789	NTIS (US Sales Only), PC A10/MF A01		DE91712980	
90-083	15:50878	NTIS (US Sales Only), PC A08/MF A01		DE91712984	
90-085	15:50879	NTIS (US Sales Only), PC A04/MF A01		DE91712977	
90-086	15:52503	NTIS (US Sales Only), PC A06/MF A01		DE91712978	
90-087	15:52504	NTIS (US Sales Only), PC A09/MF A01		DE91712979	
90-088	15:52363	NTIS (US Sales Only), PC A04/MF A01		DE91712986	
90-089	15:50842	NTIS (US Sales Only), PC A04/MF A01		DE91713051	
90-090	15:52505	NTIS (US Sales Only), PC A06/MF A01		DE91713025	
90-091	15:50784	NTIS (US Sales Only), PC A09/MF A01		DE91713042	
90-092	15:52230	NTIS (US Sales Only), PC A07/MF A01		DE91712985	
90-093	15:51392	NTIS (US Sales Only), PC A04/MF A01		DE91713026	
90-094	15:51371	NTIS (US Sales Only), PC A03/MF A01		DE91713027	
90-097	15:52231	NTIS (US Sales Only), PC A05/MF A01		DE91713052	
90-098	15:52166	NTIS (US Sales Only), PC A05/MF A01		DE91713053	
90-100	15:52584	NTIS (US Sales Only), PC A04/MF A01		DE91713043	
90-105	15:52364	NTIS (US Sales Only), PC A03/MF A01		DE91713055	
90-108	15:52585	NTIS (US Sales Only), PC A05/MF A01		DE91713056	
90-114	15:52586	NTIS (US Sales Only), PC A03/MF A01		DE91713057	
90-119	15:52506	NTIS (US Sales Only), PC A05/MF A01		DE91713082	
90-123	15:52507	NTIS (US Sales Only), PC A04/MF A01		DE91713083	
Juel–					
2312	15:50790	NTIS (US Sales Only), PC A07/MF A01		DE91712356	
2351	15:50771	NTIS (US Sales Only), PC A07/MF A01		DE91705963	
2353	15:51241	NTIS (US Sales Only), PC A08/MF A01		DE91712480	
2359	15:50791	NTIS (US Sales Only), PC A05/MF A01		DE91712357	
Juel-Spez–					
518	15:51571	Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek			
524	15:50940	NTIS (US Sales Only), PC A06/MF A01		DE91706102	
528	15:51537	NTIS (US Sales Only), PC A08/MF A01		DE91706107	
529	15:51572	NTIS (US Sales Only), PC A05/MF A01		DE91706103	
544	15:50760	NTIS (US Sales Only), PC A06/MF A01		DE91712374	
K/ESH–					
2	15:50594	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000136	MF-600
K/ITP–					
354	15:50546	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017159	MF-515

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
K/QT–					
308	15:50547	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90016000	MF-517
KCP–					
613-4426	15:51614	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000580	MF-701
613-4437	15:51091	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000579	MF-706
KEK–					
89-18	15:51538	NTIS (US Sales Only), PC A03/MF A01		DE91712889	
89-20	15:51539	NTIS (US Sales Only), PC A05/MF A01		DE91712867	
89-24	15:51573	NTIS (US Sales Only), PC A18/MF A01		DE91713116	
KFK–					
4650	15:51116	NTIS (US Sales Only), PC A06/MF A01		DE91706099	
4673	15:51540	NTIS (US Sales Only), PC A07/MF A01		DE91706308	
4674	15:51585	NTIS (US Sales Only), PC A05/MF A01		DE91706307	
4689	15:51735	NTIS (US Sales Only), PC A06/MF A01		DE91705961	
4696	15:52365	NTIS (US Sales Only), PC A05/MF A01		DE91706327	
4712	15:51289	NTIS (US Sales Only), PC A03/MF A01		DE91705962	
4725	15:52189	NTIS (US Sales Only), PC A05/MF A01		DE91706309	
KFK-PEF–					
57	15:51864	NTIS (US Sales Only), PC A09/MF A01		DE91706018	
67	15:50772	NTIS (US Sales Only), PC A09/MF A01		DE91706243	
70	15:51649	NTIS (US Sales Only), PC A08/MF A01		DE91712336	
71	15:51650	NTIS (US Sales Only), PC A05/MF A01		DE91712361	
KFTI–					
88-20	15:52311	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91603027	
88-23	15:51574	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91604564	
88-24	15:52366	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602949	
88-25	15:52285	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604880	
88-28	15:51507	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91604506	
88-29	15:52061	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603070	
88-30	15:52367	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602950	
88-31	15:52062	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603071	
88-32	15:52368	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602951	
88-37	15:51541	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604558	
88-39	15:52369	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602922	
88-40	15:52219	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603120	
88-42	15:52220	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603121	
88-43	15:52221	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603103	
88-44	15:52286	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602873	
88-45	15:52287	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91602874	
KURRI-TR–					
329	15:52235	NTIS (US Sales Only), PC A04/MF A01		DE91712931	
332	15:52232	NTIS (US Sales Only), PC A05/MF A01		DE91712932	
KY/H–					
111	15:51885	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000573	MF-403
LA–					
11661-MS-Vol.2	15:51880	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000452	PC-610
11692-MS-Vol.2	15:51417	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000581	
11826-MS	15:52508	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000887	MF-712
11839-MS	15:50553	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017853	MF-515
11905-T	15:52020	NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000885	MF-410
11906-MS	15:50747	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000685	
11941-MS	15:51703	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000018	MF-902
LA-UR–					
3229	15:50595	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000221	MF-902; MF-940

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-2932	15:51492	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000448	MF-910
90-2938	15:52509	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000447	MF-426
90-2947	15:52341	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000446	MF-910
90-2968	15:51939	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000444	MF-702
90-2974	15:52510	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000442	MF-426
90-2975	15:52289	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000441	MF-910
90-2976	15:52290	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000440	MF-910
90-2984	15:52021	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000437	MF-413
90-2988	15:51421	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000436	MF-700
90-3043	15:51542	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000434	MF-910
90-3046	15:51543	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000433	MF-413
90-3048	15:51129	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000367	
90-3052	15:51508	NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000366	MF-414
90-3055	15:52342	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000365	MF-905
90-3059	15:51917	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000364	MF-702
90-3072	15:51918	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000426	MF-910
90-3081	15:51509	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000248	
90-3082	15:51493	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000246	
90-3094	15:51544	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000245	
90-3096	15:51494	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000242	MF-910
90-3099	15:51545	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000241	MF-910
90-3127	15:52233	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000238	MF-413
90-3129	15:52291	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000237	MF-712
90-3133	15:51959	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000236	MF-700
90-3138	15:51495	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000235	
90-3144	15:51510	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000231	MF-414
90-3145	15:52587	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000230	MF-705
90-3159	15:51375	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000228	MF-721
90-3160	15:51186	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000375	MF-404
90-3166	15:51130	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000373	MF-904
90-3170	15:51242	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000372	MF-404
90-3175	15:51511	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000371	MF-910
90-3176	15:51512	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000370	MF-414
90-3180	15:51546	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000369	
90-3182	15:50941	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000368	MF-903
90-3193	15:52203	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000425	MF-413
90-3210	15:51960	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000222	MF-700
90-3241	15:51115	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000219	MF-700
90-3246	15:52511	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000218	MF-424
90-3247	15:51290	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000217	MF-901
90-3249	15:52343	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000216	MF-905
90-3253	15:52171	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000215	MF-905
90-3261	15:52512	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000213	MF-424
90-3264	15:51310	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000212	MF-731
90-3268	15:51187	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000211	MF-410
90-3293	15:51513	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000210	MF-910
90-3296	15:51547	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000209	MF-910
90-3311	15:52006	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000208	MF-910
90-3315	15:51496	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000187	MF-910
90-3322	15:51497	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000185	MF-414
90-3329	15:52292	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000182	MF-411
90-3331	15:52513	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000181	MF-910
90-3335	15:52222	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000178	MF-413
90-3344	15:52344	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000177	MF-910
90-3345	15:52370	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000176	MF-427
90-3346	15:52172	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000173	MF-910
90-3347	15:51131	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000172	MF-704
90-3356	15:51108	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000171	MF-330
90-3359	15:52022	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000169	MF-910
90-3371	15:51548	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000167	
90-3372	15:51514	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000166	
LAFI–					
145	15:52107	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602740	
147	15:51958	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602806	
149	15:52195	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603198	
151	15:52288	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602875	
153	15:52340	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602706	

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LBL–					
25393	15:51065	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000179	MF-350
27067	15:51586	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000358	MF-406
27595	15:50773	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000224	MF-105
28379	15:51549	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000250	MF-406
28635	15:51605	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000239	MF-406; MF-411
28870	15:51515	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000244	MF-414
29114-Extd.Abst.	15:51498	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000234	MF-414
29128	15:51704	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000188	MF-402
29184	15:51135	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000189	MF-404
29185	15:51136	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000354	MF-404
29257	15:51886	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000223	MF-406
29258	15:51252	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000357	MF-401
29301	15:52590	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000353	MF-405
29305	15:51253	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000356	MF-401
29311	15:51137	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000360	MF-404; MF-704
29312	15:52345	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000170	MF-213
29347	15:52023	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000243	MF-414
29360	15:51294	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000227	MF-402
29445	15:52167	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000226	MF-413
29464	15:51550	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000355	MF-422
29466	15:52063	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000225	MF-414
29478	15:51066	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000359	
29479	15:51067	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000183	
29482	15:52223	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000232	MF-413
29488	15:52024	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000190	MF-414
29490	15:51551	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000240	MF-414
LBL-PUB–					
3081	15:52612	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000378	MF-405
LIYF–					
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1522	15:51552	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604559	
LU-TP–					
90-1	15:52064	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603048	
90-5	15:52065	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603049	
LUMEDW-MERI–					
1024-1-63-1990	15:52234	*See* LUNFD6-NFRA–1024-1-63-1990			
LUMEDW-MEXL–					
1021-1990	15:51824	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604398	
LUNFD6-NFFK–					
1001-1-30-1990	15:51962	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602812	
LUNFD6-NFFR–					
1009-1-142-1990	15:52174	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603164	
LUNFD6-NFRA–					
1024-1-63-1990	15:52234	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91603090	
LUSG-WP–					
528	15:52591	Available from School of Geography, University of Leeds, Leeds LS2 9JT			
MAC–					
13533D	15:50475	PC Canadian Jorex Limited, 2870 Bow Valley Square 4, 250 - 6th Avenue SW, Calgary, AB, CAN T2P 3H7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

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MDF/PQ–					
3209-5	15:50669	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MEM–					
9(80-16)	15:51101	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
MEMO-INF–					
89-67	15:52601	*See* PB–90-254012/XAB			
MH–					
90-04957	15:50911	PC Manitoba Legislative Library, 200 Vaughan St., Winnipeg, MB, CAN R3C 1T5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MIC–					
90-03770/XAB	15:50660	NTIS, PC EE07/MF E01			
90-03856/XAB	15:51878	NTIS, PC EE07/MF E01			
90-03924/XAB	15:50486	NTIS, PC EE12/MF E01			
90-03966/XAB	15:51651	NTIS, PC EE07/MF E01			
90-03969/XAB	15:51092	NTIS, PC EE07/MF E01			
90-03999/XAB	15:51652	NTIS, PC EE07/MF E01			
90-04256/XAB	15:51887	NTIS, PC EE07/MF E01			
90-04268/XAB	15:50880	NTIS, PC EE07/MF E01			
90-04269/XAB	15:50881	NTIS, PC EE07/MF E01			
MICROLOG–					
90-02502	15:50669	*See* MDF/PQ–3209-5			
90-02866	15:50907	*See* OH/TD–87201			
90-02961	15:51871	*See* QME–PA-34			
90-03019	15:51007	*See* YM–32-1/79-37-1989-O5F			
90-03086	15:50483	*See* SPE–1/PN/2			
90-03090	15:51011	*See* EACNLMT–90-03090			
90-03115	15:50949	*See* EC–90-03115			
90-03122	15:51694	*See* CP/PQ–50			
90-03147	15:51734	*See* IWD/AR/WQB–89-152			
90-03187	15:50400	*See* NBU–89-1			
90-03191	15:50535	*See* NBRPC–90-03191			
90-03223	15:50942	*See* ML–4231			
90-03224	15:50954	*See* ML–4136			
90-03278	15:50779	*See* SDC–90-664			
90-03279	15:50778	*See* NSE–90-03279			
90-03285	15:50659	*See* FC–12-10			
90-03330	15:50774	*See* NBE–90-03330			
90-03529	15:51741	*See* OH/RD–89-276-K			
90-03588	15:50401	*See* NE–1988-03			
90-03626	15:50989	*See* OE/RT–90-03626-Vol.1			
90-03770	15:50671	*See* CS–85-50			
90-03771	15:51068	*See* NME–90-03771			
90-03902	15:50935	*See* QMER–E20			
90-03924	15:50951	*See* FEARO–106-14/1989			
90-04031	15:50485	*See* CCG–TP2526			
90-04052	15:51730	*See* FO/CAR–779			
90-04151	15:50955	*See* NBE–90-04151			
90-04183	15:50986	*See* QMER–E38			
90-04183	15:50987	*See* QMER–E39			
90-04213	15:51865	*See* OE/ARB–90-04213			
90-04218	15:51736	*See* MUN/CCORE–90-04218			
90-04243	15:51021	*See* OH/RD–90-04243			
90-04274	15:50994	*See* EBRLG–33			
90-04275	15:50497	*See* OEB–90-04275-Ed.3			
90-04323	15:51731	*See* FO/S–1171			
90-04332	15:51653	*See* OE–90-04332			
90-04349	15:51077	*See* QMER/BEEN–90-04349			
90-04350	15:51078	*See* QMER/BEEN–90-04350			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-04351	15:50996	*See* QMER/BEE–90-04351			
90-04355	15:51012	*See* QMER–90-04355			
90-04360	15:51003	*See* OEB–90-04360			
90-04401	15:50484	*See* WA–90-04401			
90-04408	15:50456	*See* CPA–90-04408			
90-04411	15:50487	*See* NRC–90-04411			
90-04488	15:50521	*See* TP–9470E			
90-04491	15:51086	*See* TP–9877E			
90-04492	15:50672	*See* TP–9519			
90-04508	15:50361	*See* CANMET–90-75(TR)			
90-04559	15:50673	*See* NBE–90-04559			
90-04599	15:50775	*See* NSE–90-04599			
90-04620	15:50491	*See* QS–8426-000-EF-A1			
90-04621	15:50482	*See* HBBT–R71-19/54-1988E			
90-04703	15:51008	*See* AE/PD–1/321			
90-04714	15:51024	*See* SPC–90-04714			
90-04730	15:51020	*See* OH–90-04730			
90-04736	15:51698	*See* ESP–90-04736			
90-04760	15:50997	*See* QMER–90-04760			
90-04766	15:51737	*See* OE–90-04766			
90-04864	15:51089	*See* DPAG–68-2/1-1OE			
90-04898	15:51004	*See* OME–301082-12/11-89			
90-04957	15:50911	*See* MH–90-04957			
MINTEK-M–					
305/D	15:51372	Available from Mintek, Private Bag X3015, Randburg, 2125, South Africa			
ML–					
4136	15:50954	PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
4231	15:50942	PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MLM–					
3654	15:51295	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90018033	PC-700; PC-701; PC-705
MLM-MU–					
90-69-0002	15:51624	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017541	MF-706
MPI-PAE/Exp.El.–					
227	15:52025	Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik			
228	15:51588	Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik			
230	15:52066	Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik			
MRC/ABQ-R–					
1208	15:52007	*See* UCRL-CR–105052			
MS–					
8651	15:51436	*See* AD-A–223716/2/XAB			
MTR–					
90W00040	15:51789	*See* AD-A–223779/0/XAB			
MUN/CCORE–					
90-04218	15:51736	PC Centre for Cold Ocean Resources Engineering, C-CORE, Memorial University of Nfld., St. John's, NF, CAN A1B 3X5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
N–					
90-7	15:52239	*See* AD-A–223427/6/XAB			
NAGRA-NTB–					
86-04	15:50596	Available from Nagra, CH-5401 Baden, Switzerland			
86-04	15:50597	Available from Nagra, CH-5401 Baden, Switzerland			
87-18	15:50598	Available from Nagra, CH-5401 Baden, Switzerland			
89-23	15:50599	Available from Nagra, CH-5401 Baden, Switzerland			
90-08	15:50600	Available from Nagra, CH-5401 Baden, Switzerland			
90-13	15:51705	Available from Nagra, CH-5401 Baden, Switzerland			
NBE–					
90-03330	15:50774	PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-04151	15:50955	PC New Brunswick Dept. of Municipal Affairs and Environment, 364 Argyle St., PO Box 6000, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
90-04559	15:50673	PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NBRPC–					
90-03191	15:50535	PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $5.10 CAN; MF $10 CAN			
NBU–					
89-1	15:50400	PC New Brunswick Legislative Library, Government Documents Section, 766 King St, Fredericton, NB, CAN E3B 5H1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $14.00 CAN; MF $10 CAN			
NCAR/TN–					
346+STR	15:51921	*See* PB–90-256330/XAB			
NCEL-TN–					
1808	15:51882	*See* AD-A–223574/5/XAB			
NE–					
1988-03	15:50401	PC Newfoundland Dept. of Energy, P.O. Box 4750, Atlantic Pl., Water St., St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NEAG–					
1TP4B-90009-(Vol.1)	15:50882	NTIS (US Sales Only), PC A12/MF A01		DE91712726	
NEB-SS–					
132-1	15:50909	National Energy Board, Trebla Bldg., 473 Albert St., Ottawa, ON, CAN K1A 0E5. Prices: N/C			
NEI-SE–					
60	15:50646	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91604864	

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NEI-SE–					
61	15:50647	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604865	
NIFS-TECH–					
1	15:52514	NTIS (US Sales Only), PC A08/MF A01		DE91713080	
NIIAR–					
15(746)	15:50844	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE91604599	
25(756)	15:50845	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604600	
NIPER–					
501	15:50499	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000884	MF-125
NIST/TN–					
1276	15:50716	*See* PB–90-257668/XAB			
NMAB–					
452	15:51119	*See* AD-A–223468/0/XAB			
NME–					
90-03771	15:51068	PC Newfoundland Dept. of Mines, Geological Survey Branch, P.O. Box 4750, St. John's, NF, CAN A1C 5T7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NMRDI–					
2-78-5202/II	15:50746	OSTI; NMRDI, Communications Office, Suite M, 457 Washington SE, Albuquerque, NM 87108		TI91000137	
NMRI–					
90-44	15:51862	*See* AD-A–223526/5/XAB			
NORD–					
1990-30	15:50883	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604797	
1990-32	15:52236	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91604387	
NRC–					
29695	15:51296	Canada Institute for Scientific and Technical Information, Montreal Rd., Ottawa, ON, CAN K1A 0R6. Prices: PRICES UPON REQUEST			
90-04411	15:50487	PC Indian and Northern Affairs Canada, Reference Centre, Les Terrasses de la Chaudie@'re, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NSE–					
90-03279	15:50778	PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-04599	15:50775	PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NUREG–					
0325-Rev.14	15:52564	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI91000125	
0750-Vol.31-Index-2	15:50838	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI91000759	
0837-Vol.10-No.2	15:51706	NTIS, PC A10/MF A01 - GPO; OSTI; INIS		TI91000252	
1396	15:51853	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI91000007	
NUREG/CR–					
3469-Vol.5	15:50884	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI91000672	
4469-Vol.10	15:50781	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI91000836	
5258-Vol.3	15:51888	NTIS, PC A06/MF A01 - GPO - OSTI		TI91000830	
5521	15:50601	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI91000838	
5530	15:50785	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI91000839	
5542	15:51254	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI91000576	
5594	15:50602	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI91000760	
5597	15:50885	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI91000837	

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5616	15:50886	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI91000762	
5622	15:50887	NTIS, PC A10/MF A01 - GPO; OSTI; INIS		TI91000673	
NZERDC–					
163	15:50262	Ministry of Commerce, Energy and Resources Division, PO Box 2337, Wellington, New Zealand			
NZERDC-P–					
123	15:50351	Ministry of Commerce, Energy and Resources Division, P.O. Box 2337, Wellington (New Zealand)			
127	15:50293	Ministry of Commerce, Energy and Resources Division, P.O. Box 2337, Wellington, New Zealand			
OCS/EIS/EA/MMS–					
90-0063	15:50488	OSTI; Minerals Management Service, 949 E. 36th Avenue, Anchorage, AK 99508-4302		TI91000009	
OE–					
90-04332	15:51653	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
90-04766	15:51737	PC Ontario Ministry of the Environment, Public Information Centre, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OE/ARB–					
90-04213	15:51865	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OE/RT–					
90-03626-Vol.1	15:50989	PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OEB–					
90-04275-Ed.3	15:50497	PC Publications Ontario, 880 Bay St, 5th Floor, Toronto, ON, CAN M7A 1N8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-04360	15:51003	PC Ontario Energy Board, 14 Carlton St., 9th Floor, Toronto, ON, CAN M5B 1J2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OH–					
90-04730	15:51020	PC Ontario Hydro Research Division, Research Publications Office, 800 Kipling Ave., Toronto, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
OH/RD–					
89-276-K	15:51741	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, ON, CAN K1A 0G1			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
OH/RD–					
90-04243	15:51021	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OH/TD–					
87201	15:50907	PC Ontario Waste Management Corporation, 2 Bloor St. West, 11th. Fl., Communications Service, Toronto, ON, CAN M4W 3E2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OIES-EV–					
1	15:50956	Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.			
OME–					
301082-12/11-89	15:51004	PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
CE03083	15:50893	Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST			
CE03182	15:51072	Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7. Prices: PRICES UPON REQUEST			
ORNL/CSD/FTR–					
3758	15:50888	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000684	
ORNL/FTR–					
3722	15:51093	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000385	MF-506
3733	15:52168	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000387	MF-414
3736	15:50856	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000045	MF-520
3738	15:50782	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000690	
3743	15:52169	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000386	MF-414
3744	15:50891	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017851	MF-220
3745	15:52515	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000381	MF-404
3747	15:51742	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000700	MF-402
3749	15:51825	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000875	MF-408
3751	15:51255	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000384	MF-404
3753	15:50786	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000382	
3754	15:51657	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000687	MF-402
3755	15:51347	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000383	MF-410
3759	15:51658	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000873	MF-402
3761	15:51190	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000686	MF-404
3763	15:51191	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000692	MF-404
3764	15:51963	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000776	MF-411
3765	15:51297	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000691	MF-407
3768	15:51866	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000874	MF-402
ORNL/M–					
838	15:51659	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017852	MF-402
ORNL/Sub–					
86-91324/1	15:51841	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017900	MF-245
ORNL/TM–					
11476	15:50785	*See* NUREG/CR–5530			
11604	15:50857	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000699	MF-520
11627	15:52613	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90018036	
11635	15:51625	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017772	
11661	15:52600	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000689	MF-400
11671	15:52178	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000871	MF-413
ORNL/tr–					
90/18	15:50548	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000882	MF-400
OTA-E–					
440	15:52316	*See* PB–90-253790/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
OTI–					
89-544	15:51431	Also available from H.M. Stationery Office, price Pound 13.75			
OTO–					
89-009	15:51432	Available from British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks.			
P–					
300-90-003	15:50476	OSTI; California Energy Commission, 1516 Ninth Street - MS 13, Sacramento, CA 95814		TI91000130	
PATENTS-USA–					
4,888,861/A/	15:51621	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,893,627/A/	15:51833	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,893,934/A/	15:51620	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,898,034/A/	15:51168	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,898,692/A/	15:51281	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,899,084/A/	15:51526	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,899,100/A/	15:51622	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,900,539/A/	15:51832	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,903,281/A/	15:50846	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,916,721/A/	15:51619	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,933,949/A/	15:51486	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,935,196/A/	15:50558	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,935,943/A/	15:50559	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,936,374/A/	15:50836	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,938,633/A/	15:51082	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,938,917/A/	15:50835	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,939,111/A/	15:51043	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,939,742/A/	15:51485	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,940,331/A/	15:51484	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
4,940,865/A/	15:51096	Patent and Trademark Office, Box 9, Washington, DC 20232 (USA)			
Application7-517,013	15:51487	NTISPC N03/MF A01			
Application7-486,638	15:51488	NTISPC N03/MF A01			
Application7-459,211	15:51489	NTISPC N03/MF A01			
PB–					
90-234725/XAB	15:51707	NTIS, PC EE99/MF E99			
90-234733/XAB	15:51708	NTIS, PC A18/MF A03			
90-238502/XAB	15:51660	NTIS, PC A03/MF A01			
90-242843/XAB	15:50957	NTIS, PC A99/MF E99			
90-242850/XAB	15:50958	NTIS, PC A99/MF E99			
90-242868/XAB	15:50959	NTIS, PC A06/MF A01			
90-243049/XAB	15:50960	NTIS, PC EE99/MF E99			
90-243056/XAB	15:50961	NTIS, PC A03/MF A01			
90-243064/XAB	15:50962	NTIS, PC A03/MF A01			
90-243072/XAB	15:50963	NTIS, PC A03/MF A01			
90-243080/XAB	15:50964	NTIS, PC A05/MF A01			
90-243098/XAB	15:50965	NTIS, PC A03/MF A01			
90-243106/XAB	15:50966	NTIS, PC A03/MF A01			
90-243114/XAB	15:50967	NTIS, PC A03/MF A01			
90-243122/XAB	15:50968	NTIS, PC A02/MF A01			
90-243148/XAB	15:50969	NTIS, PC A04/MF A01			
90-243155/XAB	15:50970	NTIS, PC A07/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-243163/XAB	15:50971	NTIS, PC A08/MF A01			
90-243171/XAB	15:50972	NTIS, PC A04/MF A01			
90-243189/XAB	15:50973	NTIS, PC A06/MF A01			
90-243197/XAB	15:50974	NTIS, PC A03/MF A01			
90-247628/XAB	15:51867	NTIS, PC A06/MF A01			
90-249434/XAB	15:50975	NTIS, PC A03/MF A01			
90-249467/XAB	15:50976	NTIS, PC A02/MF A01			
90-249608/XAB	15:50977	NTIS, PC A02/MF A01			
90-249640/XAB	15:51709	NTIS, PC A03/MF A01			
90-251224/XAB	15:51919	NTIS, PC A08/MF A01			
90-251232/XAB	15:51920	NTIS, PC A06/MF A01			
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90-252602/XAB	15:51744	NTIS, PC A06/MF A01			
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90-253204/XAB	15:51662	NTIS, PC A13/MF A02			
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90-253790/XAB	15:52316	NTIS, PC A07/MF A01			
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90-255506/XAB	15:51138	NTIS, PC A13/MF A02			
90-255530/XAB	15:50985	NTIS, PC A99			
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90-255688/XAB	15:50368	NTIS, PC A06/MF A01			
90-256140/XAB	15:51746	NTIS, PC A02/MF A01			
90-256330/XAB	15:51921	NTIS, PC A05/MF A01			
90-256405/XAB	15:51666	NTIS, PC A04/MF A01			
90-256413/XAB	15:51747	NTIS, PC A05/MF A01			
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90-256512/XAB	15:51868	NTIS, PC A05/MF A01			
90-256546/XAB	15:50489	NTIS, PC A03/MF A01			
90-256561/XAB	15:51667	NTIS, PC A04/MF A01			
90-256579/XAB	15:51749	NTIS, PC A03/MF A01			
90-256587/XAB	15:51750	NTIS, PC A03/MF A01			
90-256637/XAB	15:50978	NTIS, PC A13/MF A02			
90-256645/XAB	15:51751	NTIS, PC A03/MF A01			
90-256660/XAB	15:51668	NTIS, PC A03/MF A01			
90-256678/XAB	15:50979	NTIS, PC A04/MF A01			
90-256686/XAB	15:51710	NTIS, PC A04/MF A01			
90-256702/XAB	15:51669	NTIS, PC A04/MF A01			
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90-256736/XAB	15:51670	NTIS, PC A03/MF A01			
90-256744/XAB	15:51752	NTIS, PC A08/MF A01			
90-256777/XAB	15:51671	NTIS, PC A06/MF A01			
90-257387/XAB	15:52602	NTIS, PC A04/MF A01			
90-257437/XAB	15:51553	NTIS, PC A03/MF A01			
90-257452/XAB	15:50902	NTIS, PC A03/MF A01			
90-257668/XAB	15:50716	NTIS, PC A05/MF A01			
90-258310/XAB	15:50981	NTIS, PC A03/MF A01			
90-258427/XAB	15:51672	NTIS, PC A04/MF A01			
90-258484/XAB	15:50982	NTIS, PC A17/MF A02			
90-258518/XAB	15:51094	NTIS, PC A13/MF A02			
90-258609/XAB	15:50490	NTIS, PC A99/MF A04			
90-258799/XAB	15:51922	NTIS, PC A08/MF A01			
90-258807/XAB	15:51923	NTIS, PC A05/MF A01			
90-258864/XAB	15:51673	NTIS, PC A09/MF A01			
90-258963/XAB	15:51753	NTIS, PC A11/MF A02			
90-258971/XAB	15:51110	NTIS, PC A04/MF A01			
90-259037/XAB	15:50337	NTIS, PC A07/MF A01			
90-259649/XAB	15:51674	NTIS, PC A09/MF A01			
90-259854/XAB	15:51675	NTIS, PC A17/MF A03			
90-259961/XAB	15:51711	NTIS, PC A08/MF A01			
90-259979/XAB	15:50518	NTIS, PC A04/MF A01			
90-260076/XAB	15:51754	NTIS, PC A03/MF A01			
90-260092/XAB	15:51755	NTIS, PC A03/MF A01			
90-260100/XAB	15:51756	NTIS, PC A03/MF A01			
90-260118/XAB	15:51712	NTIS, PC A03/MF A01			
90-260126/XAB	15:51757	NTIS, PC A03/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-260480/XAB	15:50519	NTIS, PC A05/MF A01			
90-262072/XAB	15:51869	NTIS, PC A10/MF A02			
90-262114/XAB	15:51854	NTIS, PC A08/MF A01			
90-262122/XAB	15:51713	NTIS, PC A06/MF A01			
90-262817/XAB	15:51676	NTIS, PC A02/MF A01			
90-262833/XAB	15:51677	NTIS, PC A03/MF A01			
90-780610/XAB	15:50655	NTISAV$139.00			
PNC-TN–					
8410-90-018	15:51192	NTIS (US Sales Only), PC A03/MF A01		DE91713049	
PNL–					
5711-Vol.10	15:50781	*See* NUREG/CR–4469-Vol.10			
7277	15:51855	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000052	MF-407
7351	15:50886	*See* NUREG/CR–5616			
7352	15:50565	*See* DOE/NBM–1070			
7413	15:50603	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000063	MF-702
7432	15:51870	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000174	MF-602; MF-630
7439	15:51856	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000064	MF-407
7442	15:50604	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000004	MF-721; MF-705
7459	15:51626	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017710	
7460	15:51603	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000175	MF-606
7465	15:51073	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000582	MF-350
7475	15:51678	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000081	MF-602
PNL-SA–					
17301	15:50850	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017868	MF-500
17700	15:51022	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000154	MF-350
17701	15:51074	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000152	MF-350
17937	15:52603	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000417	MF-505
18025	15:51589	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000150	MF-506
18038	15:51758	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000416	MF-502
18282	15:51679	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000414	MF-630
18372	15:52604	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000454	MF-407
18422	15:51075	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000153	MF-350
18423	15:50642	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017142	MF-515
18447	15:51076	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000151	MF-350
18484	15:51023	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017867	MF-350
18521	15:52516	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000155	MF-420
POEF–					
2046	15:50555	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017532	MF-610
PPPL–					
2681	15:52517	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000487	PC-427
2717	15:52371	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000486	PC-420; PC-427
2718	15:52372	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000492	PC-427
2721	15:52373	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000505	PC-420; PC-427
2722	15:52374	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000506	PC-420; PC-426; PC-427
2723	15:52375	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000504	PC-420
PSC–					
8	15:51924	NTIS (US Sales Only), PC A03/MF A01		DE91713050	
PSI–					
72	15:50889	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604589	
PTB-Re–					
25	15:51680	Available from Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Radioaktivitaet			
PTB-W–					
40(rev.ed.2)	15:51615	NTIS (US Sales Only), PC A03/MF A01		DE91705987	
QME–					
PA-34	15:51871	PC Quebec Ministere de l'environnement, 3900, rue Marly, Ste Foy, PQ, CAN G1X 4E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
QMER–					
90-04355	15:51012	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-04760	15:50997	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
E20	15:50935	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
E38	15:50986	PC Bibliotheque du l'Assemblee Nationale, Edifice Pamphile-Lemay, Quebec, PQ, CAN G1A 1A5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
E39	15:50987	PC Bibliotheque du l'Assemblee Nationale, Edifice Pamphile-Lemay, Quebec, PQ, CAN G1A 1A5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
QMER/BEE–					
90-04351	15:50996	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
QMER/BEEN–					
90-04349	15:51077	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-04350	15:51078	PC Ministere de l'energie et des ressources, Direction des communications, 5700, 4e av. ouest, D-309, Charlesbourg, PQ, CAN G1H 6R1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
QS–					
8426-000-EF-A1	15:50491	PC Indian and Northern Affairs Canada, Reference Centre, Les Terrasses de la Chaudiere, Ottawa, ON, CAN K1A 0H4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
QU–					
CE03093	15:51079	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			

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RCM–					
01587/I+II	15:50605	NTIS (US Sales Only), PC A09/MF A01		DE91706355	
RERF-TR–					
10-87	15:51857	NTIS (US Sales Only), PC A03/MF A01		DE91712967	
19-89	15:52237	NTIS (US Sales Only), PC A03/MF A01		DE91712968	
22-89	15:51858	NTIS (US Sales Only), PC A03/MF A01		DE91712966	
3-90	15:51842	NTIS (US Sales Only), PC A03/MF A01		DE91712969	
RISO-M–					
2761	15:50754	NTIS (US Sales Only), PC A04/MF A01		DE91707334	
2852	15:50914	NTIS (US Sales Only), PC A09/MF A01		DE91707364	
2867	15:51035	NTIS (US Sales Only), PC A05/MF A01		DE91707362	
SAIC–					
89/1148	15:50887	*See* NUREG/CR–5622			
SAND–					
88-1203	15:50606	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000455	MF-814
88-2511	15:50607	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000078	MF-814
89-0688	15:51627	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000095	MF-700
89-0738	15:52614	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000094	MF-706
89-0913	15:51446	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000096	MF-906
89-2176	15:50608	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000456	MF-721
89-2563	15:51395	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000469	MF-905
89-2656	15:51256	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000098	MF-741
89-2952C	15:50609	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000765	MF-721
89-3015C	15:51634	NTIS, PC A02/MF A01 - OSTI		DE90012585	MF-721
89-3112	15:51606	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000471	MF-700
90-0127	15:50601	*See* NUREG/CR–5521			
90-0416	15:52605	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000483	MF-705
90-0440	15:51396	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000475	MF-406
90-0449C	15:51139	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000025	MF-706
90-0485	15:51635	NTIS, PC E05/MF E01 - OSTI; GPO Dep.	E 1.99:	DE91000457	MF-705
90-0495	15:50643	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90016690	PC-830
90-0612	15:50728	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000480	MF-276
90-0686	15:51631	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000079	MF-700
90-0993C	15:51140	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000038	MF-704
90-1039	15:50644	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000087	MF-515
90-1291	15:51422	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000091	MF-600
90-1470C	15:51141	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000772	MF-704
90-1495	15:51628	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000088	MF-705
90-1510	15:51397	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000458	MF-600
90-1544	15:51447	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000466	MF-410
90-1575C	15:51629	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000770	MF-706
90-1579C	15:51616	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000773	MF-706
90-1772C	15:52298	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000027	MF-706
90-1813C	15:52606	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000022	MF-705
90-1852	15:51630	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000090	MF-700
90-2068	15:50402	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000484	MF-132
90-2072C	15:51590	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90015845	MF-700
90-2128C	15:50787	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000409	MF-520
90-2198C	15:50294	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000406	MF-108
90-2203C	15:51193	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000044	MF-704
90-2251C	15:50890	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000771	
90-2320C	15:51398	NTIS, PC A02/MF A01 - OSTI		DE90017550	MF-706
90-2333C	15:51194	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000764	MF-704
90-2378C-Draft	15:50851	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000410	
90-2400C	15:51399	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000036	MF-706; MF-705
90-2419C	15:51607	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000024	MF-706
90-2470C	15:51257	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000029	MF-404
90-8224	15:51617	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000883	MF-700
SC–					
011850	15:50544	Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: PRICES UPON REQUEST			
SCIENTIFIC–					
1	15:51936	*See* AD-A–223660/2/XAB			
SDC–					
90-664	15:50779	PC Nova Scotia Legislative Library, PO Box 396, Halifax, NS, CAN B3J 2P8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SERI/PR–					
255-3443	15:50734	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000385	MF-231
SERI/TP–					
211-3905	15:50717	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000359	MF-271
211-3949	15:50718	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000371	MF-271
211-3950	15:50719	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000372	MF-273
254-3800	15:51080	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000349	MF-231
SERI/TR–					
211-3664	15:50720	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000345	MF-273
SEU–					
1	15:51098	NTIS (US Sales Only), PC A13/MF A01		DE91707841	
SGD–					
549-PT-1	15:51919	*See* PB–90-251224/XAB			
549-PT-2	15:51920	*See* PB–90-251232/XAB			
550-PT-1	15:51922	*See* PB–90-258799/XAB			
550-PT-2	15:51923	*See* PB–90-258807/XAB			
SKB-TR–					
89-20(app.)	15:50610	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604800	
89-26(app.)	15:50610	*See* SKB-TR–89-20(app.)			
90-02	15:50611	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE91604133	
90-05	15:51714	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91604134	
90-06	15:51715	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE91604135	
SKN–					
37	15:50612	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE91604801	
SLAC–					
363	15:51681	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000046	MF-402; MF-414
SLAC-PUB–					
5115	15:52027	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000460	MF-414
5232	15:51591	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000053	MF-414
5248	15:51592	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000054	MF-406
5323	15:52071	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000055	MF-410
5328	15:51517	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000057	MF-414
5330	15:51518	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000058	MF-414
5331	15:51575	NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000059	MF-414
5339	15:51519	NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000461	MF-414
5343	15:52224	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000462	MF-413
5345	15:51554	NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000463	MF-414
SLAC/AP–					
80	15:51516	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000761	MF-414
SNV–					
3744	15:51000	*See* STEV–1990-2			
SPC–					
90-04714	15:51024	PC Saskatchewan Power Corporation, 2025 Victoria Ave., Regina, SK, CAN S4P 0S1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
SPE–					
1/PN/2	15:50483	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
SSC-EN–					
106-14/1989	15:50486	*See* MIC–90-03924/XAB			
SSC-H–					
46-2/89-150E	15:51878	*See* MIC–90-03856/XAB			
SSC-M–					
44-89/22E	15:51887	*See* MIC–90-04256/XAB			
SSCL–					
310	15:51499	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000464	PC-414
311	15:51555	NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000068	PC-414
312	15:51556	NTIS, PC A01/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000069	PC-414
313	15:51557	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000070	PC-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
ST–					
90-17	15:50477	Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: $30.00 CAN			
90-43	15:50541	Energy Resources Conservation Board, 640-5th Ave. SW, Calgary, AB, CAN T2P 3G4. Prices: $30.00 CAN			
STEV–					
1989-4	15:51005	NTIS (US Sales Only), PC A14/MF A01		DE91707878	
1989-5	15:50998	NTIS (US Sales Only), PC A07/MF A01		DE91707880	
1989-6	15:50661	NTIS (US Sales Only), PC A03/MF A01		DE91707882	
1989-R10	15:50945	NTIS (US Sales Only), PC A03/MF A01		DE91707847	
1989-R12	15:50675	NTIS (US Sales Only), PC A03/MF A01		DE91707849	
1989-R13	15:50662	NTIS (US Sales Only), PC A04/MF A01		DE91707851	
1989-R14	15:51881	NTIS (US Sales Only), PC A14/MF A01		DE91707852	
1989-R15	15:50663	NTIS (US Sales Only), PC A03/MF A01		DE91707855	
1989-R16	15:50946	NTIS (US Sales Only), PC A07/MF A01		DE91707857	
1989-R17	15:50664	NTIS (US Sales Only), PC A06/MF A01		DE91707859	
1989-R18	15:50999	NTIS (US Sales Only), PC A05/MF A01		DE91707861	
1989-R20	15:50520	NTIS (US Sales Only), PC A04/MF A01		DE91707863	
1989-R21	15:51095	NTIS (US Sales Only), PC A04/MF A01		DE91707865	
1989-R22	15:51025	NTIS (US Sales Only), PC A05/MF A01		DE91707867	
1989-R23	15:51006	NTIS (US Sales Only), PC A05/MF A01		DE91707869	
1989-R24	15:50501	NTIS (US Sales Only), PC A03/MF A01		DE91707871	
1989-R25	15:50335	NTIS (US Sales Only), PC A03/MF A01		DE91707873	
1989-R26	15:50676	NTIS (US Sales Only), PC A04/MF A01		DE91707875	
1989-R27	15:51682	NTIS (US Sales Only), PC A03/MF A01		DE91707876	
1989-R9	15:50944	NTIS (US Sales Only), PC A06/MF A01		DE91707845	
1990-2	15:51000	NTIS (US Sales Only), PC A05/MF A01		DE91707884	
1990-3	15:51001	NTIS (US Sales Only), PC A04/MF A01		DE91707886	
STF–					
15A89014	15:50735	NTIS (US Sales Only), PC A03/MF A01		DE91707625	
60A89016	15:50688	NTIS (US Sales Only), PC A05/MF A01		DE91707658	
60A89018	15:50689	NTIS (US Sales Only), PC A05/MF A01		DE91707616	
STU-I–					
752-1989	15:51029	NTIS (US Sales Only), PC A06/MF A01		DE91707843	
STUDSVIK-NP–					
89-104	15:50611	*See* SKB-TR–90-02			
SUPRI-TR–					
79	15:50446	*See* DOE/BC/14126–27			
SWRI–					
03-1781-102	15:51110	*See* PB–90-258971/XAB			
TAC–					
CE03154	15:51427	BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN			
CE03155	15:51428	BiTech Publishing, 903 - 580 Hornby St., Vancouver, BC, CAN V6C 3B6. Prices: $40.00 CAN			
TES–					
CE03099	15:51099	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
CE03100	15:51100	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
TGAL–					
90-03	15:51633	*See* AD-A–223490/4/XAB			
TP–					
9470E	15:50521	PC Health and Welfare Canada, Communications Directorate, Brooke Claxton Bldg, Ottawa, ON, CAN K1A 0K9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC N/C; MF $10 CAN			
9519	15:50672	PC Air Pollution Control Directorate, Ottawa, , CAN ; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
9877E	15:51086	PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
TR–					
886	15:52570	*See* AD-A–223812/9/XAB			
921	15:52565	*See* AD-A–223436/7/XAB			
TRITA-EPP–					
89-06	15:51940	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604155	
89-07	15:51941	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604156	
89-08	15:51942	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604157	
90-01	15:52376	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91602940	
90-03	15:51943	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91604158	
90-04	15:51925	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE91603008	
TTI–					
2-10-87-1103-2F	15:51085	*See* PB–90-255654/XAB			
TUAR–					
88	15:52563	*See* EUR–12385			
UA-DE-NSS-OP–					
28	15:50478	Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
29	15:50479	Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.			
UBA-FB–					
89-062	15:51109	Copy held by UB/TIB Hannover			
89-135	15:51111	Copy held by UB/TIB Hannover			
UCID–					
21566	15:52607	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000481	MF-705
UCL-DE-DP–					
89-09	15:50947	Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
UCRL–					
100531	15:52528	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000656	MF-406
101648	15:52529	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000402	MF-712
101766	15:52299	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000260	MF-712
102340	15:51142	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000815	MF-704
102576	15:51632	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000813	MF-706
102697	15:51143	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90015911	MF-706
103780	15:51558	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000421	
15965	15:50613	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000661	MF-814
52000-90-7-8	15:50990	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000482	PC-700
97641	15:50645	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90015905	MF-700
98217	15:51448	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90015913	MF-706
UCRL-CR–					
103908	15:52530	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000947	MF-712
103909	15:52531	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000946	MF-712
103910	15:52532	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000949	MF-712
104249	15:50549	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90017088	MF-517
104738	15:50614	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000808	MF-810
104873	15:50648	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000588	MF-517
104934	15:51258	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000814	MF-704
105052	15:52007	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000803	MF-706
106064	15:51964	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000950	MF-712
UCRL-ID–					
103289	15:51490	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000485	MF-700
104090	15:52350	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000073	MF-705
104558	15:52351	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000075	MF-705
104990	15:51965	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000074	MF-700
UCRL-JC–					
101185	15:52533	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000789	MF-420

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
103285	15:52534	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000788	MF-700
103490	15:52535	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000655	MF-420
103596	15:52536	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000654	MF-423
103598	15:51449	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000657	MF-406
103668	15:51195	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000939	MF-701
103679	15:50615	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE91000257	MF-810
103784	15:51559	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000649	MF-700
103785	15:51520	NTIS, PC A01/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000651	MF-700
103786	15:51521	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000652	MF-700
103788	15:51500	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE91000659	MF-700
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238-88	15:51432	*See* OTO–89-009			
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DO Dominican Republic
DZ Algeria

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ET Ethiopia

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GB United Kingdom of Great Britain and Northern Ireland (UK)
GD Grenada
GH Ghana
GM Gambia
GN Guinea
GQ Equatorial Guinea
GR Greece
GT Guatemala
GU Guam
GW Guinea-Bissau
GY Guyana

HK Hong Kong
HN Honduras
HT Haiti
HU Hungary
HV Upper Volta

ID Indonesia
IE Ireland
IL Israel
IN India
IQ Iraq
IR Iran
IS Iceland
IT Italy

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JO Jordan
JP Japan
KE Kenya
KH Democratic Kampuchea
KP Democratic People's Republic of Korea
KR Korea, Republic of
KW Kuwait

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LB Lebanon
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LU Luxembourg
LY Libyan Arab Republic

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SL Sierra Leone
SM San Marino
SN Senegal
SO Somalia
SU Union of Soviet Socialist Republics (USSR)
SV El Salvador
SY Syria
SZ Swaziland

TD Chad
TG Togo
TH Thailand
TN Tunisia
TO Tonga
TR Turkey
TT Trinidad and Tobago
TW Taiwan
TZ United Republic of Tanzania

UA Ukrainian Soviet Socialist Republic (Ukrainian SSR)
UG Uganda
US United States of America (USA)
UY Uruguay

VA Holy See
VE Venezuela
VI Virgin Islands of the United States
VN Viet Nam

WS Western Samoa

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